

Conceptual Framework for Design of Collaborative Environments

Cultivating Communities of Practices for Deaf Inclusion

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Abstract: Members of the Deaf communities have been excluded for several years. There is a need for computational tools that take into account their peculiarities so that the Deaf may fulfill all their human possibilities. Even the systems that were supposedly designed for the Deaf present several problems (e.g. not in Sign Language (SL)). Communities of Practice (CP - a group of people who share some interest on a topic, and get together to better understand that topic) cultivate interactions. Interactions through collaborative activities mediated by computers should be used for social inclusion of the Deaf and Knowledge Creation (KC - a social process that encourages learning and development of skills). This article has two main objectives: first, it presents the results of an ethnographic study of a CP with Deaf and non-Deaf members to study SL. Second, the observations from the ethnographic study (based on collaboration and communication theories) allowed the researchers to determine some requirements, that are compiled and presented here as a Conceptual Framework to inform design of Inclusive Collaborative Virtual Environments (ICVE) to be used to cultivate CP for Deaf inclusion.

1 INTRODUCTION

Deaf communities live a historical moment in their quest for the social rights they have been denied for many years. According to Fernandes (2006, p.1), *“the right to use Sign Languages (SL) in different contexts of social interaction and knowledge access”* is one of the most important of these rights. The use of SL gives the Deaf the ability to participate in their social inclusion and is essential for citizenship. Mantoan (2005 p. 2) tells us that *“[...] inclusion is our ability to understand and recognize the other, and, therefore, have the privilege of living and sharing with different people [...]”*. In that regard, members of the Deaf communities need to have their peculiarities acknowledged so that they can fulfill all their human possibilities.

Communities of Practice (CP) cultivate interaction, and should be used to provide the Deaf with new possibilities, thus widening the expectations of collaboration with members of other communities. Such collaborations are paramount for the socialization and development of the Deaf's full potential. CP gather people of different skills and

experiences, centered around a given topic of study (e.g. Deaf issues) in order to learn more about that topic. Each member of a CP contributes with her unique set of skills to generate ideas, solve problems, make decisions, create knowledge. The interactions within a CP for knowledge creation (KC - a social process that encourages learning and development of skills) or for task performance are beneficial for learning (e.g. the learning of SL). These interactions within a CP increase the systemic learning synergy (as opposed to individual action) and should be mediated by computers.

Interactions through collaborative activities mediated by computers are relevant for social, historical, political and human formation and may contribute to the creation of the Deaf identity. However, the existing Computer Supported Cooperative Work (CSCW) frameworks lack physical, empirical and social aspects when it comes to accessibility and inclusion in general, and the Deaf issues in particular. Mainly, CSCW systems are designed for users of oral language and users who have some Information and Communication Technologies (ICT) skills.

Even among the systems that were supposedly designed for the Deaf, Trindade et al., (2011) found

several inadequacies: the use of a limited set of SL (i.e. sets that do not cover the entire language; and do not allow the user to add or change the signs on that set); the use of pre-defined videos to convey information in SL, thus limiting interaction and sharing of information; the use of alphabet and spelling (which are but a small part of SL); limited learning and information coverage; the use of the system as a mere data repository, which limits its possibilities to elaborate queries, among other issues.

Almeida (2011) presents a social-technical approach in the “FAware” framework to be used in the design of awareness in web-based Inclusive Collaborative Systems (ICS). This research proposes a conceptual framework that broadens the scope of awareness. Additionally, the proposed framework extends the focus to other requirements for collaboration and KC in CP formed by Deaf and non-Deaf members. In order to derive the proposed framework to inform design of collaborative systems for Deaf inclusion and support of the social construction of knowledge, such CP was cultivated.

The study of the interactions among the participants allowed for the observation of specificities that needed to be addressed. The analyses of such observations are presented in three (3) main foci: **elements that influence KC, the use of Acts of Speech and conversation parameters and principles of cooperation.**

The remainder of this article presents the main theories that were the basis of the research (section 2). Section 3 presents the methodological steps used. Section 4 presents an ethnographic study performed with the CP. Section 5 presents the proposed framework. Section 6 offers some considerations and future work.

2 THEORETICAL BASIS

The ethnographic study of the cultivation of the CP was based on the relation and combination of some concepts: Communities of Practice, Knowledge Creation and transformation, communication and cooperation theories, conversation analysis among others.

2.1 CP and Knowledge Creation

A Community of Practice (CP) is a group of people who share an interest or passion for some topic and who try to interact regularly in order to increase their knowledge about such topic (Lave and Wenger,

1991); (Wenger, 2010). CP build relations and ties among its members and allow for collective learning (Vidou et al., 2006). CP have a domain (the topic), community (people with shared interests) and practice (process used within the CP to learn about the topic).

CP creates a collaboration arena that promotes cooperation and KC by allowing communication and interaction among its members so that knowledge and experiences are shared in a coordinated manner. Usually, a CP provides a shared repository of routines, vocabulary, instruments, methods and techniques, actions and concepts that the CP has built or adopted throughout its existence (Silva, 2010). Table 1 compiles several relations and concepts about CP from the literature, including the ontology from Tifous et al., (2007).

Table 1: CP – Concepts and Relations. Source: adapted from Tifous et al., 2007.

CP – Main Concepts		Authors
COMMUNITY	Motivation	Wenger (2001)
	Domain	
	Practice	
	Field	Tifous et al., (2007)
	Goal	
	Structure	
	Composition	Langelier and Wenger (2005)
Cultural diversity		
MEMBERS	Personal Characteristics	Miller (1995), Tifous et al., (2007)
	Type of involvement	
	Tolerance	
	Peripheral role	
COMPETENCE	Type of Competence	Tifous et al. (2007)
COLLABORATION	Collaboration Goals	Vidou et al., (2006)
	Collaborative Activities	
	Roles involved	
	Geographic Dimension	
	Temporal Dimension	
	Collaboration resources	
	Communication means	
	Types of interaction	
	Engagement	Deaudelin et al., (2003), Weiseth et al., (2006)
	Coordination	
DECISION-MAKING	Decision-making resources	Tifous et al., (2007)
	Results	
	Actors	
	Strategies	
CP RESOURCES	Record of interaction	Tifous et al., (2007)
	CP tools	

A CP is comprised of several elements (e.g. actors, resources, competences, activities etc.) and their inter-relations needed to achieve the goals of

the CP. The ontology proposed by Tifou et al. (2007) presents the main elements, their semantics, and other contexts of CSCW, which may be used in KC tools to aid the learning process in CP.

In order to appropriate knowledge, one must additionally combine, systematize and apply it. KC occurs when the members of a CP share experiences, observe and assimilate specific skills brought in by each member. KC takes place in a CP when its members exchange ideas for decision-making and problem solving.

Knowledge is characterized as a set of items of contextualized information containing the meanings inherent to the agent that possesses it; its semantic content is a function of the set of items of information that it contains, the links with other units of knowledge and by the contextualization process (Santana and Santos, 2002).

According to Bukowitz and Williams (2002), the TIC comprised the main forces that brought into evidence KC. The TIC allowed people to share large amounts of information without concerns about geographical or temporal barriers. Information sharing is the first step towards KC: a continuous social process of goal clarification that negotiates commitment and encourages mutual learning and the development of skills (Carroll et al., 2003).

Information sharing can be tacit or explicit. Takeuchi and Nonaka (2008) tell us that tacit knowledge is related to one's personal experiences, skills, beliefs and daily life situations. Explicit knowledge refers to the contents found in texts, manuals, graphics, spreadsheets and other types of registered documents that can be shared. Knowledge Conversion is the process that changes one type of knowledge into the other. Nonaka and Takeuchi (1997) describe four types of knowledge conversion in the SECI:

- **Socialization** (tacit to tacit): share and create a tacit knowledge through direct experience;
- **Externalization** (tacit to explicit): articulate the tacit knowledge through dialog and reflection;
- **Combination** (explicit to explicit): occurs when an individual systematize and applies the explicit information and knowledge;
- **Internalization** (explicit to tacit): one learns and acquires tacit knowledge through practice.

The use of the SECI model within a CP allows for KC.

2.2 Communication and Cooperation

The CP formed for this research was culturally rich,

diverse, faced with different contexts and needs. This configuration prompted the researchers to incorporate some classical theories (e.g. Acts of Speech and Principles of Cooperation) in order to enhance the contribution of the present research. Such theories investigate the communication processes, its signs, meaning attribution and interpretation in their communicative approaches. Their descriptive powers allow for important insights about the social rules, the process of communication and cooperation to coordinate the rational behavior geared towards a goal.

The theories of communication and cooperation may help the Human-Computer Interaction (HCI) field to inform design of collaborative environments, to the extent that they offer adequate mechanisms for the user to make decisions on how to interact in the different contexts of collaboration.

The Acts of Speech Theory (Austin, 1962, Searle, 1969, 1979) work with the premise that language isn't used only to represent states in real world: languages also have an impact on such reality, and differentiate actions. Austin (1962) proposes three acts of speech: the **locutory** act occurs at enunciation time, especially the act of pronunciation by a set of articulated phonemes according to the grammar of a language; the **illocutory** act represents an intention of the speaker, and the intonation used can be translated into values; the **perlocutory** act is related to the resulting effect, in the interlocutor, caused by the uttered sentence.

Searle (1979) extends Austin (1962) and describes five classic categories for the illocutory act:

- **Assertives** (instructions, affirmations): they express the commitment to the truth in regards to the expressed proposition;
- **Directives** (request, command): they describe diverse attempts by the speaker to persuade the listener to perform some action;
- **Declaratives**: they alter the state of reality when it is uttered, by whom, for whom;
- **Commissives** (promises): they are used to commit the speaker to perform some action in the future;
- **Expressives** (reprimands, condolences): they have the goal of attracting the attention to a psychological state or attitude.

Grice (1975) complements the theory with Principles of Cooperation. The author presents four maxims that must be considered for a successful communication: Quantity, Quality, Relevance and Manner.

HCI makes use of such principles, of which rules

of consistency (related to manner) (Shneiderman, 1998), system visibility status (related to the quality) and the minimalist design (quantity, quality and manner) (Nielsen, 1996) are examples. For Barbosa (2006), a complex challenge for HCI is to use such theories to inform design of systems that will support the treatment of expressions that reflect the psychological attitudes of the user. These considerations are discussed further in Section 4.

2.3 Ethnomethodology and Conversation Analysis

Ethnomethodology is a method that HCI borrows from Sociology and Anthropology to better understand the intrinsic relations that involve human actions. Ethnomethodology is singularly based on social construction, mainly, in the method used to collect and treat data: such manner allows for a more precise description of the interaction among users, their tasks, and of the technology being used in a real environment. This rich description is of the most importance for HCI (Garfinkel, 1967).

Conversation Analysis (CA) comes from ethnomethodology and cognitive anthropology and tell us that “[...] *all aspects of action and social interaction may be examined and described in terms of a pre-determined or institutionalized structural organization*” (Marcuschi, 2003, p.6). Sacks, Schegloff and Jefferson (1974) demonstrate that people organize themselves socially through conversations. The authors observe that any given conversation have the following properties: speakers take turns; usually, only one person is speaking at a given time; more than one speaker at a time are common, but brief; transitions (from one speaker to the other) without intervals and without juxtaposition occur more often than transitions with brief intervals of minor juxtaposition; the order and the length of turns are not fixed; the length of the conversation is not properly specified; the relative distribution of turns of who is speaking when is not previously specified; the number of participants may vary. Such model should be taken into account in the design of ICVE.

In order to produce and maintain a conversation, the people involved must share a minimum of common knowledge (e.g. linguistic skills, cultural involvement and the ability to handle social situations) (Marcuschi, 2003). The German linguist H. Steger (*apud* Marcuschi, 2003) distinguishes two types of dialogue: 1) Asymmetric Dialogues, in which one of the participants has the right to initiate, coordinate, guide and conclude the interaction, along

with the power to exert pressure on the other participant; 2) Symmetric Dialogues, in which the various participants supposedly have the same rights in the organization of the conversation (i.e. choice of words, theme, time etc.).

Sacks, Schegloff and Jefferson (1974) elaborate a model for conversation based on the system of turns (i.e. each speaker takes her turn to speak), where each speaker has her turn at a time; turns are taken with the least amount of space and juxtaposition of speech and that a turn may vary in form, content and duration. The model is as follows:

1) **One speaker at a time** - this is the basic rule of conversation: in general, the speakers alternate turns, and each waits for the other speaker to finish to start speaking; 2) **Who has the right to speak and when** - this rule has two techniques: a) the current speaker chooses the next speaker, thus initiating a new turn; b) the current speaker stops, and the next speaker takes her turn by choosing herself.

Additionally, in a conversation, simultaneous speech may occur, along with juxtaposition of voices. The mechanisms used to repair such events have an important role in organizing conversations, and should be tied to the techniques of taking turns. Marcuschi (2003, p. 27) adds that “[...] *just like the taking of turns and the simultaneous or juxtaposed speech, also the pauses, silences and hesitations are important local organizers that may allow for relevant moments for the transition from one turn to the next*”.

3 METHODOLOGICAL STEPS

The current research is exploratory in nature, when it analyses the needs and challenges related to a specific group (i.e. that of the Deaf people and their need to communicate among themselves and with non-Deaf people): an area with scarce literature, for which it is difficult to derive precise working hypothesis. The objectives of this research determined the following methodological steps:

- **Ethnographic Study:** the researchers performed an ethnographic study to acquire qualitative data about the requirements necessary for communication, coordination, cooperation and knowledge creation in a CP with Deaf and non-Deaf members.
- **Elaboration of the Preliminary Model of the Conceptual Framework:** review, integration and adaptation of collaboration, CP and knowledge creation models. The results obtained

from the ethnographic study was combined with these models and incorporated into a proposed conceptual framework to inform design of virtual environments, conducive of cultivating CP for Deaf inclusion.

- **Creation of the Structural and Behavioral Models:** the preliminary conceptual framework, characterized as domain ontology, was modeled in its structural and behavioral aspects as per the approach of Martins (2009).

Section 4 describes the ethnographic study performed with a CP with Deaf and Non-Deaf members. Section 5 presents the proposed framework.

4 ETHNOGRAPHIC STUDY

An ethnographic study was conducted to investigate the needs for collaboration. The topic of interest of the CP was that of “knowledge creation about the phonology of Libras”.

4.1 Collaborative Meetings of the CP

The weekly meetings were previously scheduled as per demands and availabilities of the members. Each meeting lasted approximately for two (2) hours, over a period of three (3) months. Each meeting required the presence of at least two members of the Deaf community, an interpreter, and three members or the research group (to coordinate the meetings). The non-Deaf interpreter allowed for communication with a neutral interpretation (i.e. her role as interpreter could not influence or intervene with the Deaf’s ideas). Additionally, as a member of the CP, she also acted as a motivator to attain members’ participation, as well as she acted as a contributor, with her own set of knowledge and skills.

Deaf members had the main responsibility to share their knowledge about the phonology of Libras. They were responsible for the bulk of the KC process through sharing of their experiences and skills. The researchers were the mediators of the collaboration process, organizing and coordinating the activities. The meetings followed guidelines from INES (National Institute of Deaf Education – www.ines.gov.br) to conduct the meetings and overcome obstacles in the communication barrier between Deaf and non-Deaf members: for example, the use short and complete; no use of figurative speech; maintain a frontal, direct look when addressing the group; use the semi-circle format so

that each member could see the other, and the visual resources available. The meetings had cards with each hand configuration of Libras, white boards for sketches, and a computer system with a compilation of various parameters of the phonology.

4.2 Collaborative Meetings Analysis

The meetings were recorded. The researchers used the videos, interviews, conversations and notes taken during the meetings for the analysis, which focused on three main factors: **the elements that influenced knowledge creation; acts of speech and conversational organization; and principles of cooperation.** The analysis allowed the mapping of the implications of the occurrences in order to inform design of Inclusive Collaborative Virtual Environments (ICVE). The analysis had as its sub-units the tasks the members performed in each meeting (e.g. give an example of a sign for a certain hand configuration; provide signs that could be derived from a given sign, etc.). The actions were grouped according to their role in the collaboration in order to match the analyzed parameters.

4.2.1 Elements that Influenced KC

In order to promote KC in a CP it is necessary to guarantee that the flow of information (collect, store, analyze, disseminate and use) occur with adequate quality. The analysis of the tasks performed at the meetings followed the SECI model (Nonaka & Takeuchi, 1997) to verify the occurrences of knowledge conversion and its implications to inform design of ICVE.

The various tasks and activities performed, and the procedures regarding the flow of information during the meetings allowed for knowledge conversion to occur, both from tacit to explicit and from explicit to tacit knowledge, demonstrating that there was KC within the CP. Thus, were able to identify, for each step of the information flow process, some requirements to inform the design of ICVE:

- **Collection:** tools for communication among different actors/profiles, as well as tools for linguistic support (e.g. dictionaries, translators);
- **Storage:** record of the information exchanged, and of the results of the interaction (e.g. results from discussion, results from a task etc.);
- **Dissemination:** tools for communication and content and artifact availability. Use of adequate forms to present information to the Deaf (i.e. videos, sign writing);

- **Analysis:** tools to promote discussion and decision-making (e.g. forums, voting etc.); Adequate identification of the current speaker, to allow perception, tracking and intervention, when necessary; adequate visibility of the interpreter;
- **Use:** support to perception so that all the information in the environment (e.g. instructions, artifact, contents, etc.) is useful.

Table 2 presents the actions that occurred in each step of the process of information flow, their analysis, and their relations to the SECI model.

Table 2: Actions in CP and their relation to KC.

Process / Actions – Ocorrences in CP	SECI Model
Collection/experience exchange about Libras, Deaf culture and phonology	Direct experience, Socialization.
Storage/Record of signs in Libras and their parameters; video of the sign execution and the meetings.	Transfer and storage of tacit and explicit knowledge, Socialization and Combination.
Dissemination/Introduction and instructions; explanations about the phonological modelo f Libras.	Articulation of tacit knowledge, Externalization.
Analysis and Use/ Information translation; sign identification for each parameter of the phonology; review of the video for disambiguation and description of the signs.	Tacit and explicit knowledge are systematized, articulated and applied, Externalization, Combination and Internalization.

4.2.2 Acts of Speech and Conversation Organization

According to de Souza (2005), the user intention and the resulting effects of the use of the language have a considerable degree of relevance to communication. Myers (2002) adds that the analysis of conversations help to understand how the participants use language to organize the interaction from moment to moment. This research combines semiotics and ethnography to try to identify the role the action of language plays in the coordination in collaborative meetings. The main findings regarding the **Acts of Speech Analysis** indicate its frequent use to aid communication and coordination in the CP's collaborative environment. The modulators, principles and maxims were used to support problem solving and to allow the achievement of the goals of the meetings.

The researchers frequently used Directives, with Tact in order to encourage the members of the CP to

cooperate, by pointing out the benefits for the Deaf community the results would bring. The researchers also used Assertives with Consensus to strength the cooperation commitment among participants; and with Modesty to emphasize the researcher's basic knowledge in SL and Deaf culture. The use of Comissives with Generosity served the purpose of showing how the results would benefit the Deaf community, and to demonstrate the commitment of the researchers in the use of the knowledge created, as well as to guarantee the privacy and ethical issues. In some occasions, the use of Declaratives guided the participants in the tasks to be performed, as well as in situations of indecision or impasse. The interpreter used Expressives in the translation.

The relation of these results in regards to **implications and requirements for Inclusive Collaborative Virtual Environments (ICVE)** followed the reflections presented by Barbosa (2006) on how the Acts of Speech should be used to inform the design of collaborative systems:

- **Assertives:** Storage of what was said, and storage of the information about the context of the system in which the communicative act occurred, for later retrieval;
- **Directives and Comissives:** Mechanisms that require a response from the listener to record her intention to pursue or not the course of action in the communication. Possibility to change the context of the system (e.g. when a member commits to perform a task, it creates an expectation to modify the status of the project in the future);
- **Declaratives:** Mechanisms to implement and disseminate the changes;
- **Expressives:** "Treatment of issues such as the acquisition and maintenance of the user's trust, the right to privacy to all members and the defence mechanisms used by the members" (Barbosa, 2006, p.3).

According to Barbosa (2006), the storage of context information is necessary in order to validate the commitment of the speaker, recording the context in which the speech was uttered. Such procedure allows for future retrieval and evaluation of the speech in different contexts other than that in which it was uttered.

As for the Conversational Organization, this research identified the cooperative processes in the conversational activities and the action of language, in the way the participants guided their actions and organized conversation. The methodology defined for the meetings characterized the type of dialogue:

the interactions were more spontaneous, with little formalism. However, there were some roles and functions in the collaboration process.

In the face-to-face communication, members organize themselves easily via speech, and the interactions are more clearly perceived. Some markers were relevant for the organization of turns, such as a look, a pause, a hesitation, and the end of an enunciation among others. There occurred also some correction mechanisms. The corrections took place between the Deaf members and the interpreter when there was a disagreement about a sign in Libras. In this case, when the wrong utterance was perceived, one participant initiated the correction.

As for the **implications of these conversational aspects to inform the design of an ICVE**, the research was able to observe:

- The environment used to provide support to the CP, heavily based on task execution, caused a predominant use of questions and answers, of actions and reactions, thus minimizing the organizational difficulties of turns and of interactive sequences in this kind of environment;
- The formalization and implementation of social protocols may be useful in virtual environments in order to organize communication (turns and sequences) and the process of correction in synchronous interactions;
- Conversational agents (intelligent agents) may be used to indicate the current action (e.g. to show when the active speaker has completed her turn), point the next actions, monitor tasks, provide tips, give support in problem resolution, among others.

4.2.3 Cooperation Principles

Cooperation means that people need to perform tasks together in a shared space (be it physical or virtual). A CP stands to benefit by using Grice's (1975) cooperation principles to guide the behavior or its members to achieve the collaboration goals. The researchers analyzed Grice's conversational maxims (i.e. Quantity, Quality, Relevance and Manner) as they occurred in the actions performed during the meetings.

As for the "Quantity", the information was considered to be sufficient, given that it allowed for comprehension and agreement to establish collaboration. Mostly, there was some information loss when the interpreter tried to simplify or reduce the content in order to facilitate communication. But the group promptly corrects any misunderstanding

by questioning the information given.

The "Quality" of the information was noticed, and affected communication due to the complexity of the theme, and the lack of familiarity with the theme by the participants. Additionally, the interpreter wasn't very involved in the Deaf community, which made communication difficult at times. This is a clear call for more involvement, and for tools to mediate and support conversations between Deaf and non-Deaf people via an interpreter (e.g. thesaurus, dictionaries).

The information that was imparted to the CP was within the context of the proposed goal of the CP, thus making the information "Relevant" to the discussions and KC. There were some small periods where the CP lost focus on the tasks to be performed, but the coordinators were able to bring the CP back to focus.

The use of Libras, the natural language of the Deaf, was pivotal for the success of the meetings, and demonstrated the importance of the use of "Manner" in such bilingual environments. Libras is a complete linguistic system, with grammar and structures, a rich and expressive tool that allowed for the use of the modulators to emphasize interaction at communication time, thus supporting coordination and commitment of the members. The care with which the physical positioning of the interpreter within the room was treated paid off, allowing the communication to flow more easily.

Some of the **implications of these observations about cooperation principles to inform design of an ICVE** are as follows:

- Mediators should direct the speech to the interpreter, but with care that all members of the group perceive the yielding of turn. Mechanisms to facilitate perception, which put the focus and the context on the current speaker, are necessary to facilitate the comprehension by the Deaf. The Deaf require to be visually in contact with the utter.
- Differentiation of responsibilities may support the achievement of goals, in a collaborative environment. Due to the complexities of the various actors in an inclusive communication, there should be more investigation about the potential of an interaction mediator actor. Additionally, there should be considered that the coordination process must not impose rigid rules to the tasks, in order not to difficult interaction.
- The environment should provide mechanisms to support the decision making process (e.g. survey, voting mechanisms) when divergences occur (i.e. when no consensus is reached).

5 CONCEPTUAL FRAMEWORK

The proposed conceptual framework aims to inform the design of ICVE to support CP of Deaf and non-Deaf members. This section presents the schema of the necessary elements for accessibility, inclusion and the adequate participation of all members in such collaboration environment.

5.1 Preliminary Model

The proposed conceptual framework is based on the ontology to support CP presented by Tifous et al. (2007). The original ontology is robust and contains several elements and relations inherent in a CP. The proposed framework extends the ontology with new variables and relations that were identified in the ethnographic study presented on section 4. The remainder of this section presents the new variables: Members, Competence, Collaboration and Resources of the CP:

Members:

- **Special Needs:** members of a CP may have special needs that should be adequately addressed. In the case of the proposed framework, these needs for the environment mostly refer to the inclusive character associated with the inclusion of Deaf people.

Competences:

- **Presentation Forms:** It is necessary to better characterize the forms of information recording and presentation (i.e. videos in Libras, sign writing, images, symbols etc.).
- **Information Structure:** The structure and organization of the information that is the object of study by the CP should be such that they facilitate storage, retrieval and knowledge acquisition.

Collaboration:

- **Events:** Collaboration involves the organization of events that may include the entire CP or specific groups, depending on the context, the activities and tasks to be performed and the needs of the environment (e.g. video conference are more adequate, since they allow for visual communication).
- **Communication Mediation:** The active participation of an interpreter is necessary to guarantee communication between Deaf and non-Deaf.
- **Social Protocol:** Social protocols (de Souza, 2005) are important in collaborative environments, to aid participants to organize and

coordinate their actions (as opposed to rigid systems and formal coordination).

- **Conversational Agents:** Mechanisms to diagnose actions and to interact with users. Conversational agents may be used as marker in the organization of who has the turn to speak.
- **Responsibilities:** Different participants, with different profiles and roles have responsibilities that determine the form in which the CP is coordinated. Those responsibilities should be well defined and respected. The mediator, for example, should guide and promote interaction and collaboration.

Resources or the CP:

- **Linguistic Support Tools:** Tools to support communication that address the needs of the CP: dictionaries in SL, translators, transcription systems etc.
- **Tools for COOPERATION:** The cooperation may involve activities to be performed together by different people on the same resource (e.g. editing of a text). This simultaneous use requires cooperative editors and version control systems. In a CP where members share, point, write, dramatize on a shared document, such editors and video resources are necessary.

Figure 1 presents the preliminary proposed framework with its extensions on the ontology (Tifous et al., 2007). The new variables incorporated into the original ontology are presented in a different color (green). The model is characterized as domain ontology: it describes concepts of a specific domain of knowledge, with their properties and restrictions. The model is presented as a means to facilitate knowledge representation about CP. Next, this article will present the structural and behavioral models of the proposed framework.

5.2 Structure and Behavior

This research reuses the knowledge from ontologies to derive the structural and behavioral models of the proposed framework, according to the theories of Martins (2009). The knowledge about the tasks was captured from the preliminary model. The following procedures were used: i) identification of the tasks from the domain ontology; ii) decomposition of each task; and iii) identification of the roles involved in performing the tasks. Table 3 presents the knowledge about the tasks.

As seen in Table 3, an entity plays a role to solve problem. A role or roles were identified for the performance of each task. The main tasks were

identified and decomposed into sub-tasks, necessary in order to achieve the goals of the CP.

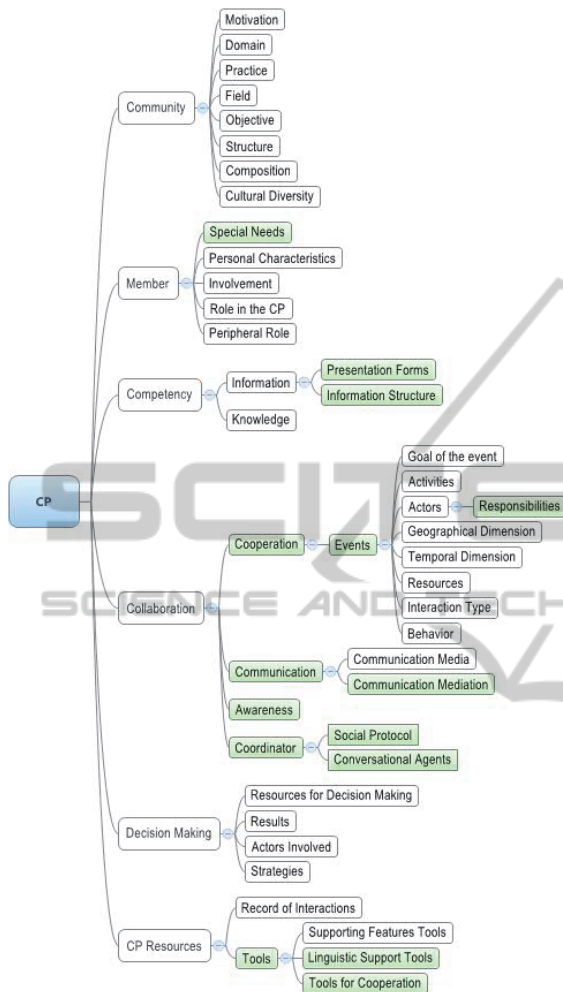


Figure 1: Preliminary proposed framework.

The diagrams that represent the behavioral and structural model of the proposed framework were derived from the domain knowledge for the CP and the tasks. Figure 2 presents a state diagram for a videoconference that illustrates the scenario of speech turn in the form of “one speaker at a time”. Such diagram demonstrates the significant aspects needed for the inclusion of the Deaf.

A videoconference between Deaf and non-Deaf may require an automatic translator, or an interpreter, to mediate communication. In so far, there is a lack of automatic translators. Thus, the interpreter is crucial in the process. Figure 2 emphasizes the behavior of “taking turns to speak”. It shows the sub-unit of the conversation where each member speaks alone in her turn, and the interpreter translates each speech.

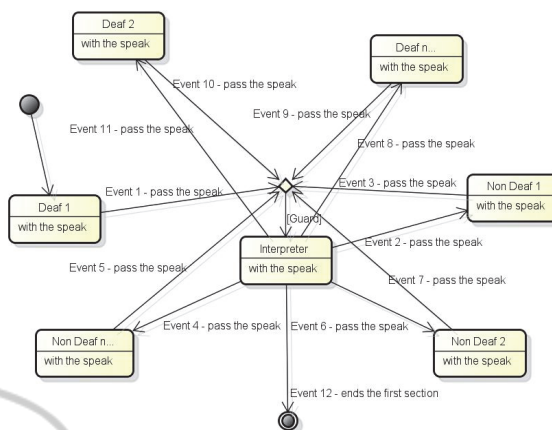


Figure 2: State Diagram – Example of taking turns “Each speaker at a time.”

This roundabout form of communication (i.e. the speakers take turns, the other participants wait for that speaker to end her turn, and then all the members have access to the a turn to speak) was used. The changing of turns may be delimited by a linguistic or paralinguistic marker (e.g. pause, hesitation, hand movement etc.). After the translation, that marks a transition of turn, the next speaker may gain the turn by self-choice.

6 CONCLUSIONS

This research provides support for the needs of the Deaf community by proposing a framework to inform the design of ICVE for CP that provides equal opportunities for the Deaf in all areas of knowledge. The CP enhance the interaction expectations, allowing the Deaf to converse and to comprehend reality surrounding her, the reality of other persons, allowing the Deaf to share information and experiences, in order to create knowledge and to develop her potentials.

The literature review provided a theoretical background with which the researchers were able to delimitate the necessary aspects for collaboration within a CP, as well as to verify the (lack of) tools for the Deaf and their limitations. The ethnographic study used such background to identify the actual aspects involved in a collaboration environment comprised of Deaf and non-Deaf within a CP.

The development of the proposed framework to inform design of ICVE allowed the researchers to identify some special characteristics: linguistic support tools are necessary in order to cultivate such CP (e.g. dictionaries in SL, translators, transcription systems, interpreters etc.); a module for the

interpreter to mediate communication; several ways to present information (videos in SL, sign writing system); adequate mechanisms for perception (the Deaf need strong visual mechanisms to point attention towards the current speaker); support to establish roles and responsibilities as a way to make collaboration possible; mechanisms to structure information for later retrieval and use, for information acquisition and knowledge creation; coordination mechanisms such as social protocols and conversational agents to guide communication.

Future works include the validation of the framework in the design of an ICVE.

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