

INTER-ANIMATION AND POLYPHONY IN COMPUTER-SUPPORTED COLLABORATIVE LEARNING

Ștefan TRĂUȘAN-MATU¹, Traian REBEDEA²

Rezumat. *Lucrarea prezintă o nouă viziune asupra învățământului colaborativ sprijinit de calculator care folosește mesageria instantanee ("chat"), plecând de la perspectiva dialogică a lui Mihail Bahtin. Sunt discutate rolul interanimării, al discursului și polifoniei în conversațiile chat, în particular și în texte, în general. Este propusă o teorie a învățământului colaborativ sprijinit de calculator, bazată pe dialogismul lui Bahtin și al muzicii polifonice. Chaturile pot deveni "mijloace de a sprijini gândirea", dacă apare interanimarea și structurarea polifonică. Lucrarea prezintă și instrumente software de analiză, care facilitează vizualizarea firelor de discuție și influențele pe care o replică o are asupra celor următoare. Astfel de instrumente pot ajuta elevii și profesorii să evalueze și să îmbunătățească procesul de învățământ.*

Abstract. *The paper presents a new vision of Computer-Supported Collaborative Learning using instant messenger, starting from the dialogic perspective of Mikhail Bakhtin of chats. The role of inter-animation, discourse and polyphony in chats, in particular, and in texts in general are discussed. A theory is proposed for Computer-Supported Collaborative Learning, based on Bakhtin's dialogism and polyphonic music: Chats may become real "thinking devices" if inter-animation and polyphonic structuring occurs. The paper also describes implemented software tools, which facilitate the visualization of the threads in a chat and the influence that an utterance has on the subsequent ones. Such tools help both teachers and learners to evaluate and enhance the learning process.*

Keywords: Computer-Supported Collaborative Learning, CSCL, Bakhtin, polyphony, inter-animation, chat

1. Introduction

In recent years, in the context of the intensive use of Internet communication tools like instant messengers ("chats", for example Yahoo Messenger <http://messenger.yahoo.com/>), many mundane activities involving natural language communication and collaboration are transferred from face-to-face toward virtual, online contact. This is also the case for learning which now may be performed in small virtual groups using chat systems [16]. Therefore, a new approach, Computer Supported Collaborative Learning (CSCL) became an alternative or supplement to classical learning.

¹Prof., Ph.D., Faculty of Automatic Control and Computers, "Politehnica" University of Bucharest, Romania, Corresponding member of the Academy of Romanian Scientists (stefan.trausan@cs.pub.ro).

²Teaching assistant, Faculty of Automatic Control and Computers, "Politehnica" University of Bucharest, Romania.

Koschmann [9] proposed Mikhail Bakhtin's dialogism [2, 3] as a paradigm for work under the CSCL paradigm, emphasizing multivocality and polyphony as key features of this theory. Wegerif [21] joins, considering also dialogism as a basis, which can be used for developing tools for teaching thinking skills. He emphasizes the role of inter-animation as a desideratum for a successful collaborative learning process. However, until now, almost no investigations and developments were performed on how these ideas could effectively be used for the analysis of CSCL dialogs and for the implementation of supporting computer tools. The research presented here started from the idea to fulfill this lack, investigating how Bakhtin's theory of polyphony and inter-animation can explain some phenomena that appear in CSCL chat conversations and how this theory can be used for the analysis and the support of collaborative learning chat conversations. Moreover, several computer tools were implemented and investigated [18].

Computer Supported Collaborative Learning is not only a consequence of the spread of Internet communication tools. It is also a new approach in computer-based support tools for learning because it is a paradigm shift from a knowledge transfer perspective (knowledge as a commodity that can be transferred or acquired from a recipient to someone's mind) to a socio-cultural view (knowledge is built socially [9, 16]). The socio-cultural learning paradigm was initiated by Vygotsky [20], and had a permanently increasing influence on learning theories, especially after the evidence of the limitations of the Intelligent Tutoring Systems paradigm, based on the knowledge acquisition model [9]. As Deborah Hicks mentioned: "Learning occurs as the co-construction (or reconstruction) of social meanings from within the parameters of emergent, socially negotiated, and discursive activity" ([8], quoted also by Koschmann [9]). The same idea is introduced also by Sfard [15]: "rather than speaking about 'acquisition of knowledge,' many people prefer to view learning as *becoming a participant in a certain discourse*".

The paper continues with a presentation of Bakhtin's ideas and how they may be used for a theory of CSCL. The third section describes several software tools for analysing chats, which implement the theory introduced by the author.

2. Bakhtin and CSCL

Polyphony, inter-animation and other basic ideas introduced by Bakhtin are very well suited for building a theory of CSCL using instant messenger dialogs ("chats"). In learning, students have to understand the domain they learn and they have also to learn how to think. In addition, they need to become able to emit competent utterances, to build discourses, to communicate, to become members of a community of knowledgeable persons in the studied domain and to master the

specific speech genres. For all these problems, useful suggestions may be found in Bakhtin's work, as we will see below. Moreover, Bakhtin's ideas may be used for implementing computer programs for analyzing students' chats in order to automatically give them feedback and grades [5, 18].

A desideratum of any learning process is that students achieve *understanding* of taught concepts. A suggestion about how to do it is implicitly provided by Voloshinov: "*Any true understanding is dialogic in nature. Understanding is to utterance as one line of dialogue is to the next*" [19]. From this perspective, dialogue is fundamental in understanding. Nevertheless, Bakhtin's dialogue should not be reduced only to a true, face-to-face conversation, where we can hear only the voices of the talking persons. Dialogue is a fundamental feature of human language-based communication and the extension of the concept of voice should be enlarged. Even inner speech is, as Vygotsky also noted, a "unique form of collaboration with oneself" [6].

Dialogue occurs also in any written text, Bakhtin's dialogism becoming a substrate for a theory of how people think, learn and understand. This is in consonance with Lotman's conception of text as a „thinking device" [22], determining that:

“The semantic structure of an internally persuasive discourse is not *finite*, it is *open*; in each of the new contexts that dialogize it, this discourse is able to reveal ever new *ways to mean*” [2].

Text becomes an opening toward dialogue, a thinking device that cultivates understanding and learning. In the same time, dialogue may be extended towards any text and even any human kind of communication, for example based on sound and image. In fact, polyphony in music is an elaborated dialogue in which a series of voices construct a coherent discourse. It can become even a model for achieving coherence in a community of voices in general, for example a group of students that construct knowledge learning together or a group of researchers that perform creative activities for example in design. In our work, we take this polyphonic model for analyzing and assessment of Computer Supported Collaborative Learning.

In the same idea, *utterances* at Bakhtin have a wider extent than it is considered in computational linguistics [11]. They range “from a short (single-word) rejoinder in everyday dialogue to the large novel or scientific treatise” [4].

An important fact, as Wertsch remarked, is that “an utterance can exist only by being produced by a voice” [22]. Moreover, as Bakhtin emphasized, each utterance is, in fact, filled with a multitude of voices, it cannot be separated from the communities in which men live and from the *others*:

“The very being of man (both external and internal) is the *deepest communion. To be means to communicate.... To be means to be for another, and through the other, for oneself*” [3].

CSCL is essentially based on community work. Here also Bakhtin has a very interesting suggestion. Communities of voices have an additional, *unmerged* character:

“The intersection, consonance, or interference of speeches in the overt dialog with the speeches in the heroes’ interior dialogs are everywhere present. The specific totality of ideas, thoughts and words is everywhere passed through several unmerged voices, taking on a different sound in each” [1].

This dual nature of community and the individuality of voices are expressed by Bakhtin also by the concept of *polyphony*, that he considers one of the main merits of Dostoevsky novels [1]. The relation of discourse and communities to music was remarked also by Tannen: “Dialogue combine with repetition to create rhythm. Dialogue is liminal between repetitions and images: like repetition is strongly sonorous” [16].

A very important idea brought by Bakhtin, related to the above-discussed characteristics of utterances, is that of speech genres, that determines “definite and relatively stable typical *forms of construction of the whole*” [4]. Speech genres may be seen also as an additional form of coherence besides intentional and attentional states identified by [7]. To acquire knowledge may be seen as the ability of building a discourse in a given speech genre (e.g. mathematics): “to learn is to become a skilled member of communities of practice and to become competent at using their speech genres” [16].

Discourse, together with dialogue, has a much complex meaning in Bakhtin’s (and Voloshinov and Medvedev) writings, getting the position of a prime philosophical category:

“Bakhtin profoundly redefined the Word itself and attempted to infuse it with its original Greek sense of logos (“discourse”). For Bakhtin, words cannot be conceived apart from the voices who speak them; thus, every word raises the question of authority” [6, 12].

Mihailovic goes even further, saying that Bakhtin’s “slovo” denotes sometimes a

"communality of those interacting with it and not any particular word or utterance", with “roots in ancient Greek and theological sources (...) *Interpenetration (vzaimo-proniknovenie)* is a term that Bakhtin frequently uses to characterize dialogue [12], a perspective at odds with the idea of ‘mixing’.” [14].

In the same philosophical context, Bakhtin considers that between ideas and words is a very important relation:

”The *idea* is a *living event* In this respect the idea resembles the *word*, with which it forms a dialogical unity. Like the word, the idea wants to be heard, understood and ‘answered’ by other voices, from other positions. Like the word, the idea is by nature dialogical” [3].

Bakhtin’s ideas, as also Wertsch remarked [22], are an elaboration of Vygotsky theory [20] of speech internalization: “For Vygotsky, the word is a powerful amalgam: part sign, part tool, it is *the* significant humanizing event” [6]. From another point of view, "discourse lives on the boundary between its own context and another, alien, context" [2]

An essential attribute of narrative, of *discourse* is that it has sense only if there are at least two persons. We could say, of course, that we many times think, individually, we remember stories or we organize our experience in an internal discourse. Thinking is, in fact a discursive activity. Bakhtin remarked the “primordial dialogism of discourse” [2], that the

“dialogic orientation of discourse is a phenomenon that is, of course, a property of *any* discourse. On all its various routes towards the object, in all its directions, the word encounters an alien word, and cannot help encountering it in a living, tension-filled interaction. Only the mythical Adam, who approached a virginal and as yet verbally unqualified world with the first word, could really have escaped from start to finish this dialogic inter-orientation with the alien word that occurs in the object. Concrete historical human discourse does not have this privilege: it can deviate from such inter-orientation only on a conditional basis and only to a certain degree.” [2].

That means that narratives, that discourse as the essence of language, is a multi-voiced, a sharing, a collaborative activity, even if we are alone on a deserted island: “an utterance belonging to a particular speaking subject and outside this form it cannot exist” [4].

Moreover, discursive voices weave in a polyphonic texture, feature that he admired so much in Dostoyevsky’s novel, characterized as “a plurality of independent and unmerged voices and consciousnesses” [3]. However, polyphony is not only a randomly overlay of voices, it has musicality, it is in fact one of the most complex type of musical compositions, exemplified by the complex contrapuntal fugues of Johann Sebastian Bach.

“When there is *more than one independent melodic line happening at the same time* in a piece of music, we say that the music is contrapuntal. The

independent melodic lines are called counterpoint. The music that is made up of counterpoint can also be called polyphony, or one can say that the music is polyphonic or speak of the polyphonic texture of the music.” [13].

Discourse in Bakhtin’s vision, by its multi-voicesness and inter-animation is almost obviously related to collaborative learning, being in fact associated with group cognition in CSCL: “The discourse-based conception of group cognition as proposed here rejects Descartes’ notion of thinking as a mental activity of individuals.” [16].

The central ideas in CSCL are collaboration and the introducing of another vision on how we should consider learning.

Learning is viewed as a process of knowledge construction and, what is very important, knowledge is no more considered something exclusively personal, something that is inside our mind and may be represented in some symbolic structures (as is stated in artificial intelligence and cognitive theories). Instead an individual mind perspective and instead considering learning as a transfer of a commodity named knowledge from a teacher to a student, in CSCL learning is not only individual but also associated to discourse as group knowledge building, as group cognition [15].

In this process, the main role is taken by the discourse, by the sequence of utterances of the dialog of the participants in the collaboration, exchanged in a human language: “knowledge is interactively achieved in discourse and may not be attributable as originating from any particular individual” [16]. Moreover, discourse seems to be more than a simple sequence of utterances. For example, Tannen sees discourse as related to music and discusses about repetition, dialogue, and imagery as means for creating involvement [17]. One essential attribute that all the above have in common is repetition and, related to it, rhythm.

3. Computer-based tools for analyzing polyphony and inter-animation in CSCL conversations

When somebody listens Johann Sebastian Bach’s fugues or even other classical music works, she remarks how several themes and their variations are exposed, developed and re-exposed by several instruments.

Moreover, these themes and their variations seem to inter-animate (even the name of musical “fugue” expresses exactly the idea that several voices are “running” and “chasing” one each other), becoming a playful ground for creativity (a particular type of polyphonic musical piece is called even an “invention”).

As we have seen in the previous section, Bakhtin used the musical metaphor for linguistics, considering that “the voices of others become woven into what we say, write, and think” [9].

Therefore, for analyzing CSCL chats, it is a good idea to investigate how voices are woven in discourse, how themes and voices inter-animate in a polyphonic way.

This is important not only to understanding how meaning is created but also for trying to design tools for support and evaluation.

Catalin	In primul rand avantajul acestui sistem il constituie comunicarea in timp real
Catalin	și nu neaparat in format scris ci cu dinamă folosind video și voce
Catalin	și de multe ori un manager asigneaza taskuri subalternilor iar online conferențele oferă o soluție eficientă pentru a lega mai mulți oameni aflați in diverse colțuri ale planetei
Catalin	ajutajul unei astfel de discuții se poate face dinamic fiecare invocând dreptul la replica iar managerul oferindu-i când considera ca este necesar
Catalin	și astfel o discuție poate avea sens și poate duce la ceva constructive
Catalin	Această soluție este mai bună decât o convorbire de la un telefon mobil datorită accesibilității, multi-sharingului de informații etc
Gabi.V	Eu susțin blogul ca mijloc colaborativ pe web. De ce? Poate unul dintre avantajele cele mai evidente, cel puțin în comparație cu chatul, este acela că nu necesită sincronizare între utilizatori. Stim cu toții cât de greu ne-a fost și noua să stabilim această întâlnire virtuală. Închiptuiți-vă dacă este vorba despre mai mult de 4 utilizatori!
Gabi.V	Un alt avantaj considerabil este acela al posibilității de structurare foarte bună. Creatorul blogului își poate expune punctul de vedere sau problema de rezolvat, iar ceilalți pot apoi, într-un mod liniar, să își aducă raportul la problema respectivă.
irina.C	Termenul "wiki" poate suna ciudat la început... până să ca termen istoric modul în care a luat naștere primul astfel de sistem, WikiWikiWeb, este interesant
irina.C	dar să revenim la ce oferă wiki
irina.C	Un alt avantaj este și cel menționat de domnul Verzea în cadrul sistemului său... și anume faptul că este asincron. Într-adevăr, deși mai mulți utilizatori participă la crearea unui articol, nu este necesar ca toți să fie online simultan.
irina.C	Ca aspecte importante trebuie reținut conținutul mare de informație care va fi pus la dispoziție angajatorilor: un bagaj mare de cunoștințe, fiecare va împărtăși din experiența sa, va putea pune la dispoziție link-uri, iar celălalt va căuta și avea idei sau probleme similare poate completa.
irina.C	Este o sursă de informație nepretuită, ușor de utilizat (un simplu Search) și ușor de întreținut (adaugare, editare și ștergere a articolelor user-friendly).
irina.C	Cam asta oferă Wiki.
irina.C	Mai sunt alte propuneri? :)
Irina.B	interesantă abordarea dumneavoastră
Irina.B	dar ce ziceți de forum? ești în același timp o modalitate de comunicare și un instrument util și ce necesită să ajungă la destinație rapid, dar și posibilitatea de a acoperi mai pe larg un subiect de larg interes, cu detaliere personală și colaborativă
Irina.B	forumul oferă această gamă largă de avantaje, cum ar fi flexibilitatea organizării, folosind topicuri și threaduri la obiect
Irina.B	spre deosebire de wiki unde un subiect este dezvoltat de către mai mulți utilizatori, dar fără să fie reținute detaliile fiecărei editări, pe un forum subiectele cresc prin reply-uri controlate
Irina.B	de asemenea informația necesară poate fi accesată foarte simplu, căutându-se în baza de date sau cu referința exactă la threadul dorit
Catalin	În general blogurile sunt scrise nu pentru a răspunde la probleme ci pentru ca fiecare să își răspundă la probleme și să-și spună părerea despre ceva fie că a fost întrebat sau nu, mai degrabă află dintr-un blog ce pasiuni are omul decât să-și pună informații utile sau răspunsuri care îl preocupă
Irina.B	într-o firmă consider că trebuie să existe un control asupra discuțiilor și asupra drepturilor utilizatorilor, de aceea este nevoie de un administrator care să modereze aceste lucruri, spre deosebire de celelalte tehnologii unde de acest lucru nu este posibil
Irina.B	deșigur, îi lipsește o anumită sincronizare dar nu este nevoie de aceasta în fiecare moment într-o firmă
Gabi.V	acesta este într-adevăr, numai unul dintre utilizările unui blog. Dar un director de firmă ca dumneavoastră bineînțeles că este capabil să treacă dincolo de această utilizare de bază și să vadă utilitatea specifică nevoilor firmei sale.
Irina.B	un mediu colaborativ nu presupune lucru real-time, și găsim unor rezolvări la problemele sale
Irina.B	chiar dacă chatul are un oarecare avantaj în faptul că este în timp real, nu este necesar acest lucru decât în 5% din cazuri probabil, și să nu mai vorbim de delay-uri și conexiuni proaste
Catalin	Probabil va fi destul de greu domnule Verzea să convingeți oamenii să scrie într-un blog ce vrei dumneavoastră nu ce vor ei, personal nu știu cum o veți face
Irina.B	și nu în ultimul rând, forumul are posibilitatea de a anunța angajatăii de noile reply-uri aparute în topicurile care le sunt de interes
Irina.B	de exemplu un angajat de la departamentul de achiziții nu va avea nevoie să știe ce se întâmplă în dep. de contabilitate și de fapt nici nu ar trebui să știe
Gabi.V	Blogul va fi pur și simplu expunerea problemei de rezolvat, după care fiecare participant își va posta propriile comentarii. Libertatea de exprimare va fi mult mai mare decât pe un chat dezorganizat și mai ușor de urmărit decât pe un forum

Fig. 1. Several threads in a chat.

During conversations, each of the participants introduces new variations or derivatives on the theme of the chat or iterates an already uttered theme variation.

Similarly to a musical piece, the chats for CSCL have a main theme, a topic that is, for example, the problem to be solved or the product to be designed by the students.

This theme generates threads of discussion containing interactions that may be identified and classified according to classes of interaction patterns. These threads contain variations (sub-topics) of the theme, in the same way as musical variations. One fundamental issue in polyphony is the presence of several participants (or “voices”) uttering (“singing”) in an unitary way in a given moment. Among the participants, short dissonances may appear, but these are “solved” and a unity is obtained. In this longitudinal-transversal space, voices behave in an unity-difference manner (or centripetal-centrifugal [2]) and display inter-animation patterns.

As an example, let us consider a chat, from which an excerpt is presented in figure 1, performed by students at a Human-Computer Interaction course at the Computer Science department of the “Politehnica” University of Bucharest. They had to discuss about what facilities and tools should have a collaborative environment. Among their utterances, several links may be easily discovered, for example repetition, as mentioned above.

The links among utterances form threads. In figure 1 are emphasized three such threads, which include only very simple links: repetition of words. All these threads, in addition to their intrinsic longitudinal nature, due to their co-presence in the same time, influence each other, inter-animating in different ways. For example, in figure 2 is represented a part of the inter-animation process among the students in the development of the threads of the links in figure 1. Time flows from left to right and the same representation of the themes is kept. In addition to the sequential dimension of themes development, in the same figure are represented also (by thick arrows) three interactions between themes, which may be considered as transversal interaction patterns (two divergent and one convergent).

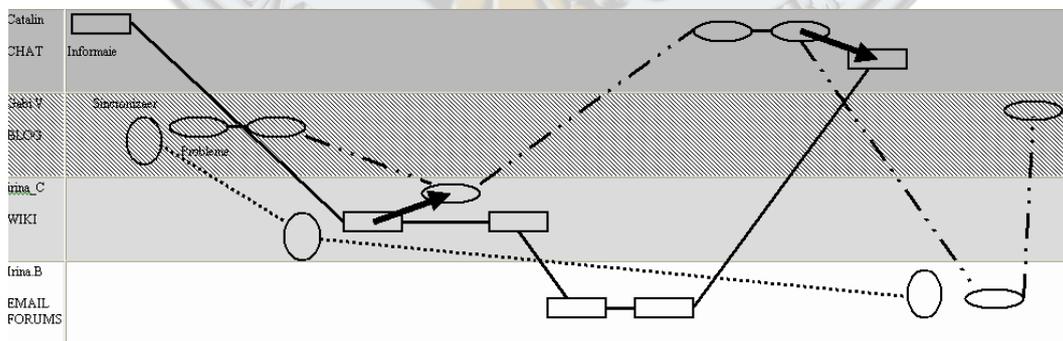


Fig. 2. The longitudinal-transversal dimensions.

Specific inter-animation patterns may be identified along each of the unity and difference dimensions in a chat [18]. In CSCL, each of these patterns may be used for automatic abstraction of useful data, either for the participants in a chat, or for teachers, towards evaluation purposes. A graphical representation of chats was designed and implemented [18], in order to facilitate an analysis based on the polyphony theory and to permit the best visualization of the conversation. For each participant in the chat, there is a separate horizontal line in the representation and each utterance is placed in the line corresponding to the issuer of that utterance, taking into account its positioning in the original chat file – using the timeline as an horizontal axis (see figure 3). Each utterance is represented as a rectangular node having a horizontal length proportional with the textual length of the utterance. The distance between two different utterances is proportional with the time passed between the utterances [18].

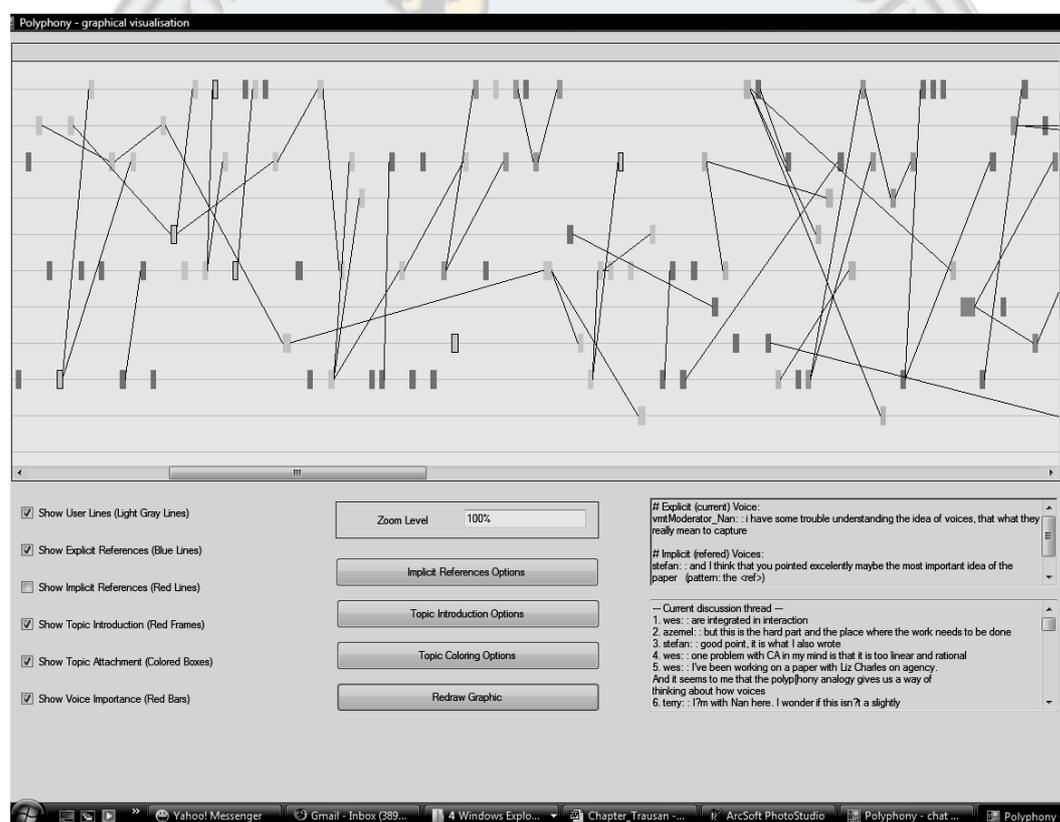


Fig. 3. Automatically detected links.

One of the most important goals in any collaborative learning process is the assessment of the contribution of each learner. For CSCL using chat conversations, in order to determine the contributions of the participants, a graphical representation was implemented starting from the polyphonic theory

and the analysis method [18]. The evaluation of the contributions of each learner is considering in what degree they have influenced the conversation. In the terms of our polyphonic model, we evaluate in what degree they have emitted strong utterances that influenced the following discussion, or, in other words, in what degree the utterance became a strong voice. An utterance is considered strong (it is becoming a strong voice) if it influences the continuation of the conversation. The contribution of each participant is computed by accumulating the strengths of the utterances she emitted [18].

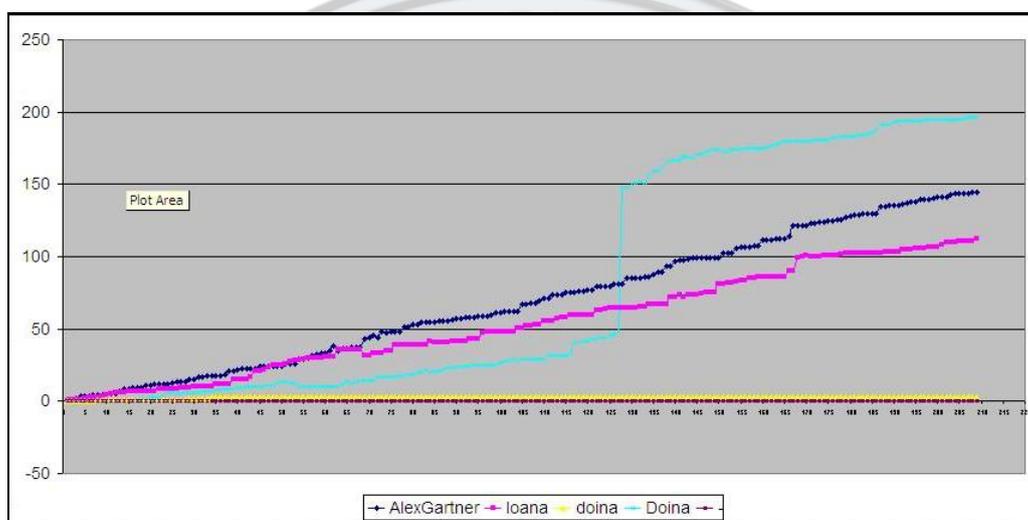


Fig. 4. Evaluation of the evolution of the contribution of the participants.

The automatic analysis considers the inter-animation patterns in the chat. It uses several criteria such as the presence in the chat of questions, agreement, disagreement or explicit and implicit referencing. The diagram is generated using a series of parameters like: implicit and explicit reference factors, bonuses for agreement, penalties for disagreement, minimum value for a chat utterance, penalty factors for utterances that agree or disagree with other utterances as these utterances have less originality than the first ones. In addition, the strength of a voice (of an utterance) depends on the strength of the utterances that refer to it. If an utterance is referenced by other utterances that are considered important, obviously that utterance also becomes important.

Conclusions

Bakhtin's ideas may be used as a basis for understanding phenomena in collaborative chats. A theory was proposed for CSCL, starting from the polyphony and inter-animation phenomena. Moreover, software tools were developed for visualizing and analyzing the chats. Experiments were performed which demonstrate the usefulness of the tools for both students and professors.

Acknowledgments

The research presented in this paper was partially performed under the FP7 EU STREP project LTfLL, and the national CNCSIS project K-Teams.

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