A debate dashboard to enhance on-line knowledge sharing

Conference or Workshop Item

A Debate Dashboard to Enhance On-Line Knowledge Sharing

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Structured Abstract

Purpose – Web 2.0 technologies have radically modified the way in which knowledge is created, managed and shared, improving productivity and accelerating innovation processes for the enterprises. These technologies have allowed enterprises to produce knowledge, leverage collective intelligence and build social capital on a scale that was unimaginable a few years ago. In this paper we focus on a particular kind of web-based collaborative platforms known as *argument mapping tools* and we discuss the main barriers to the adoption of them. Literature has proved that these argument mapping tools provide large and small and medium enterprise with several advantages, but nevertheless, they have low level adoption. In this paper we explore new technological solutions to support the adoption of argument mapping tools. In particular, we propose the design of a Debate Dashboard to provide visual feedback to support online deliberation. These visual feedback aims at compensating the loss of information due to the mediation of the technology. The Debate Dashboard is composed of a set of suitable visualization tools that have been selected on the basis of a literature review of the visualization tools.

Design/methodology/approach – We propose a literature review of existing visualization tools. Building on the literature review we selected thirty visualization tools, which have been classified on the basis of the kind of feedback they are able to provide. We identify three classes of feedback: Community feedback (identikit of users), Interaction feedback (about how users interact) and Absorption feedback (about generated

content and its organization). We distilled the Debate Dashboard features by building on results of a literature review on Web 2.0 tools for data visualization. As output of literature review we selected six visualization tools. We consider these selected tools as a sort of starting point. Indeed, our aim is the improvement of them through the addition of further features and functions in order to make them more effective in providing feedback.

Originality/value – Our paper enriches the debate about computer mediated conversation and visualization tools. We propose a Dashboard prototype to augment collaborative knowledge mapping tools by providing visual feedback on conversations. The Dashboard will provide at the same time three different kinds of feedback about: details of the participants to the conversation, interaction processes and generated content. This will allow the improvement of the benefits and reduce the costs deriving from the use of mapping tools. Moreover, another important novelty is that visualization tools will be integrated to mapping tools, as until now they have been used only to visualize data contained in forums (as Usenet or Slash.dot), chat or email archives

Practical implications – The Dashboard provides feedback about participants, interaction processes and generated contents, thus supporting the adoption of mapping tools as technologies able to foster knowledge sharing among remote workers or/and customers and supplier.

The integration of Debate Dashboard with common online argument mapping tools aims at enabling the following advantages:

1. Reduction of misunderstanding;
2. Reduction of cognitive effort required to use argument mapping tools;
3. Improvement of the exploration and the analysis of the maps - the Debate Dashboard feedback improves the usability of the object (the map), thus allowing users to pitch into the conversation in the right place.

Keywords – Debate dashboard, On-Line knowledge sharing, Visualization tools, grounding costs.

Paper type – Academic Research Paper

1 Introduction

As global competition is increasing, collaboration is becoming a key factor for the success of the enterprise. A second generation of Web technologies has provided enterprises with new models and tools for sustaining and improving collaboration and co-creation. These digital platforms are collectively labelled "Web 2.0" technologies (Musser and O'Reilly, 2006).
Web 2.0 has allowed enterprises to produce knowledge, leverage collective intelligence and build social capital on a scale that was unimaginable a few years ago.
The combination of Knowledge Management (KM) tools and Web 2.0 collaborative technologies has enabled team members, geographically dispersed, to collaborate (Hayden, 2004), capture, exchange and share knowledge in easier, cheaper and more pervasive way than traditional KM systems (Duffy, 2000). These new collaborative platforms have radically modified the way in which knowledge is created, managed and shared, improving productivity and accelerating innovation processes for the enterprises.
Online collaboration platforms allow enterprises to develop "out of box" capabilities for collectively generating, sharing and refining information and business knowledge. Indeed, workers, partners, suppliers, customers and other possible stakeholders are considered as co-producers of new knowledge and skills that are crucial for competitive advantages.
One of the most acclaimed features of Web 2.0 is its participatory aspect. People are able to collaborate and interact freely, through tools like Social networking, Blogs, Wiki, Forum etc.
Literature suggests that Web 2.0 technologies encourage a more human-oriented approach to interactivity on the Web, supporting a better group interaction and fostering a greater sense of community in a potentially "cold" social environment (Wallace, 1999).
In this paper we focus on a particular kind of web-based collaborative platform known as *argument mapping tools*. These tools provide a web-based user interface that allows users to co-create, navigate and edit argument maps. *An argument map is a representation of reasoning in which the evidential relationships among claims are made wholly explicit using graphical or other non-verbal techniques* (van Gelder, 2003).
Literature has proved that these argument mapping tools provide large and small and medium enterprise with several advantages (Skyrme, 1998), but nevertheless, they have low level adoption.
In this paper we explore new technological solutions to support the adoption of argument mapping tools. In particular, we propose the design of a Debate Dashboard to provide visual feedback to support online deliberation. These visual feedback aims at compensating the loss of information due to the mediation of the technology. The Debate Dashboard is composed of a set of suitable visualization tools that have been selected on the basis of a literature review of the visualization tools. Main objective of the Debate Dashboard is to provide visual information about several aspects of the online deliberation process in a small amount of space. In this paper we present the results of the literature review that informed the selection of the Debate Dashboard components.

2 Argument mapping tools

An argument map is a visual representation of simple or complex reasoning on any topic. Each reasoning presupposes the existence of propositions standing in logical or evidential relationships with each other, and thus forming evidential

structures. This set of propositions can be expressed or visualized as an argument map (van Gelder, 2003).
An important feature of argument maps is that they allow users to present complex reasoning in an easy to follow, clear and unambiguous way.
The term *"argument mapping"* indicates the act of producing such maps, as well as modifying, viewing and sharing them.

The literature suggests that tools for argument mapping can provide several advantages, such as: i. improving large scale knowledge understanding, ii. supporting complex reasoning in a more effective way, iii. driving conversation and favouring deliberation processes (van Gelder, 2003), iv. encouraging critical thinking and reasoning (Buckingham Shum and Hammond, 2004), v. expanding our capacity to grasp complex discussions (Conklin, 2003).
On the Internet, there are numerous examples of online argument mapping tools available for free (Cohere, Cope_it!, MIT Deliberatorium, Debategraph etc.), nevertheless these technologies seems to struggle to reach widespread diffusion both in small and large-scale organizations is low. The literature suggests that one of the causes of limited adoption is in that the benefit/cost ratio is too low for the average user to use the technology (Davis, 1989). We build on Davis's Technology Acceptance Model (TAM) (Davis, 1989) the analysis of the visual feedback that the Debate Dashboard needs to provide in order to improve the level of technology acceptance.
As the TAM model (Davis, 1989) suggests, in order a technology to be adopted, it is necessary that the benefits are higher than the costs that derive from the use of it. To identify the costs deriving from the use of online argument mapping tools we need to define the barriers to conversation introduced by these tools. In order to do so in the next section we introduce the Common Ground and Grounding Cost theories, on which we base the hypothesis we make that one of the main barrier to adoption of online argument mapping tools is the loss of information and feedback during conversation.

3 Mutual understanding in online argument mapping tools

Common Ground is defined as a premise for mutual understanding in communication processes and it consists of shared information, mutual knowledge, mutual beliefs, and mutual assumptions (Clark & Carlson, 1982). Building Common Ground is crucial for effective communication and collaborative work since it helps people to converse and understand each other.
According to Clark and Brennan (1991) communication is a collective process; it is a joint action in which participants have to coordinate their actions and their cognitive activities.
During a conversation, participants exchange, in addition to information, also evidence and/or requests for evidence, which help them understanding if the listeners have understood or have not understood what the speakers have said. Once the information has been understood, it is used to update participants' shared information. Common ground is incrementally built on the history of joint actions between communicators, and it leads to greater efficiency or a minimum effort for communication.
The process of making the understood information part of their common ground is called *grounding process* (Clark and Brennan, 1991). The grounding process is always adaptive to the current context of communication. In other words, it depends on the purpose of the conversation - what people try to accomplish in their communication – and the means that participants use to communicate - the "techniques" available in it for accomplishing that goal and the cost to use them.
Clark and collaborators identify ten constraints (see table 1 pg. 7) that a medium can impose on a conversation between people. The more constraints a medium

can provide, the better the medium is for facilitating common ground and facilitating effective communication. Indeed, without these constraints, a major collaborative cognitive effort is necessary for the participants in a conversation to understand each other and ground what has been said.
Clark and Brennan measure collaborative cognitive effort through *grounding costs*. They affirm that any mediated conversation has a higher grounding cost compared to everyday face-to-face conversation, since mediation forces people to use alternative grounding techniques.
According to Clark and Brennan's theory, the main barrier to the adoption of mapping tools is, as for other mediating tools, the lack of these key constraints. The lack of them causes the loss of information that could help people to understand each other and ground what has been said during a conversation.
In addition, argument mapping tools are objected-oriented technologies and therefore all information about the participants and the generation process of the content are missing or hidden. This makes more complicated mutual understanding and grounding process.
Argumentation technologies add a further obstacle to the conversation because they force the users to respect pre-established communication formats and rules. Therefore, the loss of immediacy, due to the formalization, coupled with the lack of information about users, interaction processes, and generated content, entails a higher cognitive effort and time consumption to learn how to use the tool.
All this makes the benefit/cost ratio too low for the average user, thus causing limited adoption (Davis, 1989) of online argument mapping tools.
To tackle this problem we propose the use of the Debate Dashboard in order to provide visual feedback about users, their interaction processes and generated content.

4 Feedback description

Online argument mapping tools leave users blind to a range of information that is commonly readily available in face-to-face interaction (Smith and Fiore, 2001) and this hamper the level of users' acceptance of these technologies.
In the case of online argument mapping tools, users lose information about three crucial elements of conversation that aid to make conversation and grounding process easier and smoother; that is:

- Participants (speakers and hearers),
- The interaction process through which the content is generated
- The content of a discussion.

On the basis of these identified crucial elements of conversation, we define three different categories of feedback that can reduce collaborative cognitive effort, as well as grounding costs:

- **Community (who):** this set of feedback allows users to know who are the community members, to visualize the community structure and to develop a sense of membership (Kim, 2000).
- **Interaction (how):** this class of feedback allows users to understand how the members of online community interact and what is happening in the online community.
- **Absorption of knowledge (what):** these feedback are about the content generated through interaction among users and its organization.

We believe that providing this feedback, we can help people to communicate in better and easier ways, to reduce misunderstanding, to facilitate grounding process and to reduce its associated costs.

4.1Community Feedback

There is growing evidence that many online communities fail due to lack of involvement by members (Kim, 2000). Through community feedback we aim support the development of a sense of membership within the online community and to improve the acquaintance of other community members. The kind of feedback that belongs to this class is:

- **Profile:** we provide name, age, place of birth, e-mail address, job/occupation, hobbies etc.;
- **Organizational/Social structure:** we provide feedback about social network structure of online community and about hierarchy (meta-moderator, moderator, editor) in it.
- **Activity level (users and groups):** we provide a holistic view of history online community and of groups.

4.2 Interaction feedback

As specified in section 2 Clark and Brennan (1999) and Kraut *et al.* (2001) identified ten constraints that a medium can impose on the communication between two people.

When one of these constraints is missing, there is a higher cost of the conversation, because mediation forces people to use alternative grounding techniques.

In the case of online argument mapping tools the grounding cost is very high since eight out of ten constraints are missing (see table 1 pg. 7), that is co-presence, audibility, visibility, tangibility, mobility, contemporality, simultaneity and sequentiality. Instead, in online mapping tools users' contributions can be both reviewed by all users (reviewability constraints) and revised privately before being sent (revisability constraints).

Thanks to interaction feedback we can compensate those constraints that in conversation mediated by argument mapping tools are missing.

We have to clarify that we do not intend to provide feedback about all the missing constraints. Indeed, we decide to not provide feedback about:

- Tangibility - because is not reproducible virtually;
- Audibility - because we choose to not reproduce it since we do not want to use online argument mapping tools as instruments that support a videoconference.

In the following table, we describe the six feedback as defined by Clark and his collaborators and how adapted by us.

Table 1: Affordance in communication media

Affordance	*Clark et al.'s definition*	*Our adapted definition*
Audibility	Participants hear other users and sound in the physical environment	Participants hear other users and sound in the virtual environment
Copresence	Users share the same physical environment	Participants are mutually aware that they share a virtual environment
Cotemporality	B receives at roughly the same time as A produces	Participant receives the message at roughly the same time as the other produces (in real time)
Mobility	Users can move around physical space	People can move around in a shared virtual environment
Reviewability	B can review A's message	Message do not fade over time but can be reviewed
Revisability	B can revise message for B	Message can be revised before being sent
Simultaneity	A and B can send and receive at once and simultaneously.	Participants can send and receive messages at once and simultaneously
Sequentiality	A's and B's turns cannot get out of sequence.	Participants can understand and see the reply structure
Tangibility	Participants can touch other people and objects in the physical environment	Participants can touch other people and object in the virtual environment
Visibility	A and B are visible to each other	Participants see the actions of the others user in the shared virtual environment

Our adaptation from Clark and Brennan (1991) and Kraut *et al.* (2002)

We have to introduce also an important clarification about sequentiality. In the case of online argument mapping tools, users' contributions are provided in a logical rather than time-based representation. Thus, the lack of the sequentiality feedback is a choice. In the same time, this property, which is supposed to be an important element of online argument mapping tool, it is actually one of the major responsible of disruption of smooth interaction. This happens because speakers do not have immediate evidence about hearers' understanding of their utterances and so they cannot repair eventual misunderstanding. This involves a further cognitive effort to grounding exchanged knowledge during a conversation.

4.3 Absorption feedback

Thanks to this feedback we enhance the understanding of the structure of discussions and their evolution. Moreover, through this feedback we support exploration and analysis of the conversation.

To put it differently, these feedback improve the usability of the object (the map), allowing users to pitch in the conversation in the right place.

The sub-classes of feedback that belong to this category are:

- **Relevance:** we provide feedback that help users to identify and recognize chunk of relevant information.
- **Structuring:** we provide feedback that help users to create relations and links between different chunk of information. In this way, people can find trends, patterns or structures in a large scale databases. Through the structuring of chunks of information, users could better understand the meaning of them, because they can comprehend the "context" in which they are used. In the following part we will explain how we would create the structuring and thus how we could help the contextualization of these chunks of information (see paragraph 5.2.6).

5 The definition of the Debate Dashboard

5.1 What is the Debate Dashboard?

"*A dashboard is a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance*" (Few, 2004).

A Dashboard allows to visualize large amount of information and to provide feedback in a consolidated and easy-to-read way.

Our Debate Dashboard will provide users with three categories of visual feedback, as defined in the previous section, about: i. users, ii. the interaction process between them, iii. the content generated by them. This feedback aims at reducing grounding costs and making the benefits associated with using arguments maps more evident.

The feedback will be provided through different visualization tools that we selected on the base of a literature review.

Visualization tools have been proved to be effective in representing huge amounts of data and to facilitate human understanding so that salient information becomes apparent (Nguyen & Zhang, 2006). We aim at exploiting these capabilities to provide feedback within a specifically designed Debate Dashboard. Its components will work in a closely coupled way; this means that multiple representations are linked together in a way that any manipulation and change of values in one view creates a similar change in the linked ones. Moreover, users will are able to use this visual representations also to explore the data. We think that this will allow users to look at data through different perspective, perceive new information and discover new insights.

5.2 A survey on visualization tools

We distilled the Debate Dashboard features by building on results of a literature review on Web 2.0 tools for data visualization.

We have to specify that we still do not have implemented the Debate Dashboard, but we have identified and "designed" the visualization tools that will compose it.

For defining the features of visualization tools that will compose our Debate Dashboard we have thoroughly reviewed thirty visualization tools.

As we want to setup a dashboard and use these visualization tools as benchmark, in the review, we focused on those one already implemented and in use in real online communities and not on those that were only defined and projected "on the paper".

Some of these visualization tools are available online and user can directly upload their data and then produce graphic representations for others to view and comment upon (for instance, see http://manyeyes.alphaworks.ibm.com/manyeyes/; http://prefuse.org/).

We analyzed each of them to understand what are their key features, how they work, what kind of feedback they provide, and if there is any "best practice" has emerged; in other words, used them to "inspire" the design and in the implementation of the Debate Dashboard.
We analyzed them on the basis of the feedback that we have identified (see section 3). Moreover as main criteria for the selection of the visualization tools, we considered:

- the number of feedback that each of them provides, in order to reduce the number of used visualization tools;
- the combination of feedback, in order to provide all individualized ones.

As output we selected six visualization tools (see table 2 pg. 13).
Clearly, we consider these selected tools as a sort of starting point. Indeed, our aim is the improvement of them through the addition of further features and functions in order to make them more effective in providing feedback.
In the next paragraph we analyze each selected visualization tool and explain why we have selected it.

5.2.1 Chat circles II: Copresence, contemporality, mobility, simultaneity and visibility

Chat Circles is a chat interface designed to enhance social interaction by intuitively structuring the conversation, that is, giving the user a better sense of the other participants by depicting the activity they are performing in the virtual space (Donath and Viegas, 2002).
This visualization tool represents logged in users as a colourful circle on the screen (*copresence feedback*). Circles brighten when a user edits a post and they grow to accommodate the text inside them (*contemporality, simultaneity and visibility feedback*). They fade and diminish in periods of silence (*visibility feedback*), though they do not disappear completely as long as the participant is connected. Moreover, the circles move around the screen simulating their movement between different topics in the chat. They leave a trace that fades over time (*mobility feedback*).
We preferred this tool respect the other ones because it is the unique able to provide mobility feedback and because it retrieves four other feedback at the same time. In this way we can minimize the number of visualization tools that we have to implement to provide all feedback.
Another important feature that "pushed" us to select this tool is the sequence of growing and shrinking circles that creates when different users talk; this creates a pulsating rhythm on the screen and reflects the turn taking of regular conversations. Thus the users feel as part of a discussion in a group. Also Coterie (Donath, 2002) has these features, but we had to opt for Chat Circles II because Coterie does not provide mobility feedback.

5.2.2 PeopleGarden: sequentiality and individual's history

PeopleGarden (Xiong and Donath, 1999) can be defined as a data portrait of users based on their past interactions and activity. It uses a flower and garden metaphor. Users are represented by a flower. The longer they have been involved, the higher the stem. Initial postings are in red, replies in blue. Each thread is a garden full of flowers. The reply structure is represented through a bud on the answered petal.
PoepleGarden provides a holistic view of the community and of the groups.
In our sample, there were other visualization tools able to provide sequentiality feedback, such as ForumReader (Dave *et al.,* 2004) and Loom (Donath, 2002). ForumReader allows users to visualize only temporal order of the flow of

conversation without considering also the reply structure followed by the users (like twitter). While, we did not choose Loom because we think that its representation is not so clear and easy to read.
In addition, PeopleGarden is able to provide two kind of feedback and as we have already mentioned we want to reduce number of used visualization tools.

5.2.3 Exhibit: Profile feedback

Through this tool we can know geo-location of our interlocutors and this can enable the development of sense of membership.
Exhibit uses a world map and on it there are users' pictures. If you click on each picture you can visualize more information about them.
It is the unique analyzed tool able to provide this kind of feedback.

5.2.4 Comment Flow: Social/organizational structure feedback

Comment Flow (Donath, 2008) allows to visualize communication behaviour. In addition it provides other three important information:

- the temporality of the conversation (through the opacity of the nodes based on the age of the last message posted by a specific profile),
- if a relation is one vs. two way,
- the quantity of information exchanged (through a marks along the edge).

In our sample there are several visualization tools able to provide social/organizational feedback, but we selected it because it is the unique that provided this further information.
Two valid competitor tools are Comment Flow and flowerGarden. The latter provides three different kind of feedback such as social/organizational structure, individual's history and relevance. As we selected PeopleGarden to provide sequentiality feedback (see paragraph 4.1.2), we opted for Comment Flow in order to provide social structure feedback. We made this choice because we did not want to use again flowers (as in PeopleGarden) as social proxies to represent data and provide feedback.

5.2.5Worlde: Relevance feedback

Wordle enables us to see how frequently words appear in a given text. The size of a word is proportional to the quantity associated with that word.
In our sample there are different visualization tools that are able to provide the same feedback, that is TagCloud (Hearst and Rosner, 2008), TheMail (Viegas *et al.*, 2006), ThemeRiver (Havre *et al.*, 2002), flowerGarden.
TheMail uses the same idea of Worlde but applied to the mail. It has a interesting feature that maybe we could use for our representation, that is 'yearly words' (the most used terms over an entire year) are represented as large faded words shown in background; while monthly words (the most used words over a month) are represented yellow and shown in foreground. In fact, it adds also a temporal characteristic to the representation.
TagCloud represents the tags frequency, but we want to use it to indicate the most used words, and not the more tagged.
Finally, we believe that ThemeRiver could be more adapt to represent the evolution of a discussion/group. In addition, Worlde is easier to read and understand.

5.2.6 Conversation Map: structuring feedback

Conversation Map (Warren, 2000) analyzes the text of an archive and its output is a semantic network. It is plotted like a spider web, so that the child nodes of the root are drawn at a certain radius out from the root, the

children of the children are drawn a bit further out in a ring around the children. If two nodes in the semantic network are connected, it means that they have often been used in the same way in the archive. In other words, if two terms are connected together, they have been calculated to have been "talked about" in similar way in the dataset (for instance, two or more terms appear one or more time as the subjects of a same verb).

6 Practical implication

In this paper we have presented our ongoing research project to design a Debate Dashboard in order to provide feedback on participants, interaction processes and generated contents in online communications mediated by argument mapping tools. By providing these feedback, the Debate Dashboard aims at enhancing the adoption of argument mapping technologies as technologies able to foster knowledge sharing among remote workers or/and customers and supplier.

Literature has already proved that the integration of visualization tools with computer-mediated communication technologies enable the following advantages:

- Improvement of the coherence of discussion (Donath, 2002);
- Easy identification of workers' knowledge, skills and competencies (Danis, 2000);
- Development/Increase of awareness of presence and activity of other workers (Danis, 2000; Erickson *et al.,* 2000).

The integration of Debate Dashboard with common online argument mapping tools aims at enabling, besides above-mentioned advantages, the following ones:

4. Reduction of misunderstanding;
5. Reduction of cognitive effort required to use argument mapping tools;
6. Improvement of the exploration and the analysis of the maps - the Debate Dashboard feedback improves the usability of the object (the map), thus allowing users to pitch into the conversation in the right place.

7 Conclusion and Future Work

Our paper enriches the debate about computer mediated conversation and visualization tools. We propose a Debate Dashboard to augment online argument mapping tools by providing visual feedback on conversations. The Debate Dashboard will provide three different kinds of visual feedback about: details of the participants to the conversation, interaction processes and generated content. This will allow the improvement of the benefits and reduce the costs deriving from the use of argument mapping tools.

Through visual representations, human beings can process and understand more easily and quickly huge amount of knowledge by taking advantage of their visual perception capabilities (Nguyen & Zhang, 2006) and reducing their cognitive effort.

The selection of visualization tools represents the first step for the definition of a visual mock-up of the Debate Dashboard.

Future work will focus on the realization of an evaluation test to assessment if these visualization tools are effective in providing the feedback we have identified (see section 3).

We want to start testing the visualization tools making semi-structured interviews to mapping tool experts (Compendium, Cohere, Debategraph etc.). We have already selected our sample of experts and defined the design of the evaluation study.

We expect to collect experts' feedback, suggestions and comments through experts interviews able to inform both the evaluation of the selected visualization tools and more broadly the definition of the features of our Debate Dashboard.

Table 2: Selected visualization tools

Visualization Tool	Chat Circles II	Comment Flow	Conversation Map	Exhibit	PeopleGarden	Wordle
Copresence	X					
Cotemporality	X					
Mobility	X					
Simultaneity	X					
Sequentiality					X	
Visibility	X					
Relevance						X
Structuring			X			
Profile				X		
Activity Level					X	
Social/organizational structure		X				

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