# STORM: Brainstorming collaborative web environment oriented to the educational context

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*Abstract*— **This paper details the design and development of a collaborative system that allows using the Brainstorming technique. This technique is widely used at various educational levels, and its development through computer systems adds favorable aspects both for teachers and students. STORM is a tool oriented specifically to the educational environment that allows developing Brainstorming sessions, considering the stages of idea generation, subsequent analysis of the contributions, and the connection of the various ideas in a relational map.**

***Keywords- ICTs in Education; Collaborative Systems; Brainstorming***

## I. INTRODUCTION

Brainstorming is a group work technique that favors the production of new ideas on a given topic or issue.

Its main rule is to postpone judgment, since initially every idea is valid and none should be rejected. Usually, during a problem-solving meeting, there are many ideas that might have been useful but die prematurely due to a "sensible" observation about their uselessness or nonsensical nature. As a consequence, these ideas are prevented from generating other ideas through an analogy process, and participant creativity is inhibited [1]. Tactically, a brainstorming session initially is focused on the number of ideas, disregarding quality and valuing originality. In the case of group sessions, any member of the group can contribute ideas of any nature that the participant believes are applicable for the case under consideration. A later analysis stage strategically deals with the qualitative validity of the production stage of the technique.

Its main purposes are to break with the usual limitations for producing ideas and generate a set of ideas from which to choose.

The application of this technique can be part of a collaborative learning strategy. That is, once the idea contribution stage is over, student discussion, negotiation, and participation can be fostered in such a way that a joint construction of the session issue is done.

In general, it has been used in the context of on-site educational processes, on various levels, with students and teachers working face-to-face [2] [3]. However, with the recent integration of Information and Communication Technologies (ICTs) to the teaching and learning processes, a series of systems that allow supporting, either fully or partially, the development of a Brainstorming session has been incorporated. Thus, time-space barriers become more flexible, and it is possible to record and store the development of the session to analyze the results, among other benefits.

This work is part of a final graduate project that included a research and development process in relation to collaborative systems that support the Brainstorming technique. In this sense, a review of a set of this type of applications was carried out to analyze their strengths and weaknesses and then use the results of the analysis as a starting point for the design and development of the STORM system. This is a contribution to web collaborative systems specifically oriented to education, and it will be added to the tools available in a virtual teaching and learning environment (WebUNLP), as part of a research line that studies these topics.

In the following section, a set of features typical of collaborative systems is presented. These features have been mentioned by various authors and have been used both for studying typical applications as well as for developing STORM. In Section III, some of the applications studied are summarized, using as analysis criteria a series of aspects of interest (specifically for the educational environment). Then, the STORM system is presented, and the main design and functionality decisions are discussed (Section IV). Finally, the assessment carried out is detailed, together with the results obtained.

## II. FEATURES OF COLLABORATIVE SYSTEMS

There is a series of desirable features in a collaborative system that are mentioned by several authors (some with different names), and that are believed to be essential when designing one of these applications. They are detailed below [4] [5]:

### *A. Awareness*

It is the perception of system elements with respect to space and time; usually referred to as “staying aware of others”. Space and time information involving other users must be constantly updated.

### B. Coordination

It is an activity in itself that helps organize the tasks of the members of the group (e.g., coordinating an action). This activity is required for establishing the tasks that will be the responsibility of each user and when they will be carried out. Thus, there is no risk of several users performing the same task or simultaneously modifying a shared resource.

### C. Collaboration

This refers to activities carried out as a group. All users take part in the activities by contributing their knowledge to achieve a final goal.

### D. Cooperation

This is a coordinated activity with a division of tasks among the members of the group.

### E. Communication

Collaborating users need to interact in various ways. To this end, they require tools that allow them to exchange opinions. These tools can be synchronous or asynchronous and can be based on text, sound, or video.

When designing STORM, all these features were considered. The main focus was on collaboration as the basis for carrying out a Brainstorming session. Coordination is essential, both for contributing ideas as well as for their subsequent analysis. Therefore, various mechanisms have been devised to introduce this feature. Awareness is inherent to collaboration, and there are various elements that have been added to STORM to reinforce this. Finally, cooperation and communication are also part of the strategies considered to support the Brainstorming technique in the system presented here.

## III. ANALYSIS OF SOME COMPUTER APPLICATIONS THAT SUPPORT THE TECHNIQUE

As part of this research, some companion systems of the Brainstorming technique that are used to carry out sessions were analyzed. The analysis was not thorough because its purpose was to get familiar with a few cases to be aware of their possibilities.

A set of features were proposed to assess all systems and be able to compare them. The following were considered:

- Type of license,
- User-friendliness,
- Languages supported, in particular, availability in Spanish,
- Target context (educational, business, or both),
- Type of system (Web or desktop),
- Possibilities for synchronous and/or asynchronous collaboration;
- Possibilities for communication among users
- Supported functionalities that are directly related with the brainstorming technique

Based on research goals, special interest was placed on finding systems that are targeted to the educational context, are based on the Web, allow both synchronous and asynchronous collaboration, offer free access, are open source, and offer an appropriate mediation of the brainstorming technique, allowing not only the contribution of ideas but also their subsequent analysis and purging.

Web-systems were emphasized due to the inherent advantages of this type of applications. Thus, the participants in a brainstorming session would be able to access the software application through a Web browser without any type of installation required. This also allows developing the technique under the different space/same time or same space/different time scheme.

Of all systems that were studied, those with Web support are Worthidea, Bubble.us, Scriblink, Twiddla, and Dabbleboard.

Also, only a few of the systems mentioned have direct support for the technique; most of them can eventually be adapted for carrying out a brainstorming session, but currently mainly allow contributing ideas. Many of them are Web whiteboards that could allow the session moderator to write down the ideas contributed by group members, but they do not offer tools for analyzing, discarding and valuing the ideas at a subsequent stage.

Among desktop applications, the following were studied: VYM, FreeMind and Brainstorm. Only the last one (Brainstorm) supports the Brainstorming technique in its stages of idea generation and their subsequent analysis. The other tools allow drawing a mental map and charting the generation of ideas of one person.

Brainstorm, unlike the others, is not multiplatform.

The strongest aspect of these systems was user friendliness. Table I shows a summary of each application in relation to some of the aspects reviewed:

TABLE I. FEATURES OF THE SYSTEMS ANALYZED

| *System* | *Free* | *Open Source* | *Language* | *Platform* | *User participation* |
|---|---|---|---|---|---|
| Worthidea | No | No | Spanish | Web | Simultaneous participation |
| Bubbl.us | Yes | No | English | Web | Simultaneous participation |
| Twiddla | Yes, basic version | No | English | Web | Simultaneous participation |
| Dabbleboard | Yes, basic version | No | English | Web | Simultaneous participation |
| Scriblink | Yes | No | English | Web | Up to 5 users simultaneously |
| VYM | Yes | Yes | English German | Desktop | Not a collaborative system |
| Freemind | Yes | No | English | Desktop | Not a collaborative system |
| Brainstorm | Purchase, 30-day trial | No | English | Desktop | Not a collaborative system |

After analyzing the systems mentioned above, some useful ideas were noted, such as voting on contributions in the Worthidea system, the way in which ideas are charted in Dabbleboard, the possibility of communicating through system chat as in Twiddla or Scriblink, among others [6]. However, no collaborative system was found that supports the Brainstorming technique and offers all desirable features, supporting both idea generation and the subsequent analysis and session review stages. In the following section, the main decisions made in relation to the STORM system are discussed.

## IV. DESIGN CONSIDERATIONS FOR STORM

From the study mentioned above, some desirable properties for an education-oriented brainstorming system were chosen. A first prototype was developed (STORM 1.0), and it has evolved based on the assessments carried out. In the following paragraphs, the main elements of the system designed are detailed.

### *A. Basic features*

The prototype allows working with an essential component of the brainstorming technique - the sessions. Each session has two types of users: a moderator (creator of the session) and the participants.

The session is carried out in stages, each of which allows different types of actions.

The goal of the session (in accordance with the purpose of the technique) is that participants generate a wealth of ideas that can be later on analyzed.

STORM allows user registration through a form that grants access credentials. Since the system has been specifically devised to be used in educational contexts, the following specific roles are available:

*1) Administrator,* responsible for changing user roles. It can also perform configuration tasks on the system.

*2) Professor,* responsible for moderating sessions. It can create, configure and coordinate sessions.

*3) Student,* with participant access to sessions.

Session participants can be either students or professors. There is no limit to the number of participants in each session, although it is advisable by the technique not to go beyond a certain number.

The moderator of a session can configure basic properties, add or remove session stages (only if the session has not begun), edit session properties, add or remove participants, and activate and end the session. Participants can be active or observers. The latter can only view what goes on in the session; they cannot perform any actions. This role was considered to allow the inclusion of participants who record some aspects of interest of the process.

On the other hand, each session is characterized by a series of stages with title, duration (optional) and description that can also be fixed or configurable. Fixed stages are those that are part of the session by default. These are: the idea contribution stage, with only one action enabled that of contributing relevant ideas, and the results stage, that allows viewing a summary of the development of the session.

There are two types of configurable stages – analysis or relation, and they have a set of actions that are selected by the moderator. The number of configurable stages is also determined by the moderator, and they are added between the idea contribution stage and the results stage.

The behavior of each stage is defined through the available actions for the stage. Upon addition, the stage has a basic set of actions that can then be expanded by adding other actions available in the system. If a teacher selects the analysis type,

the system offers, for example, the possibility of grouping ideas based on a specific instruction, and/or communicating in a synchronous manner to make decisions and/or vote for ideas. If the user selects a relation type, there will be a different set of actions that cannot be modified by the teacher.

### B. Possible functionality in each session stage

The stages included in a session are related to the development of the Brainstorming technique. In the following paragraphs, the decisions made in relation to the functionality included in each stage are described.

*1) Idea generation stage:* it can be configured to be carried out in a synchronous or asynchronous manner, based on the option selected when creating the session. With the synchronous option, the system allows participants to take turns, through the intervention of the session moderator that enables participation upon user request, by means of a raising hand system. In the asynchronous mode, all participants can contribute ideas whenever they want. This is a fixed stage, and is the first one. In the case of a synchronous stage, a robust notifications system has been included that allows for the awareness feature mentioned in Section II above. Thus, all participants are aware of the desire of contributing an idea – or not – of the others, when they are granted participation, if they are writing the idea, and when they have finished writing it.

*2) Idea analysis stages:* there can be more than one analysis stage (depending on what the session moderator has decided). The only restriction is that these stages must occur between the idea contribution stage and the results stage. Three actions can be enabled for this type of stage: setting synchronous communication through the chat tool, voting/discarding ideas, and grouping ideas. At least one of these three actions has to be selected for the analysis of ideas to be carried out. In this version of the system, chat communication is via text. Its purpose is exchanging ideas or asking questions during the session. The voting and discarding ideas action allows participants, after having generated the ideas, to show their agreement with the contributions made by other participants. To do this, all participants are notified that they can vote during the analysis stage; after the stage is finished, a ranking of ideas is shown based on the results obtained. The moderator can decide to remove ideas based on some given criteria. Everything that takes place within the system is notified to participants as it occurs, following the awareness principle. Finally, the grouping ideas action is synchronous and allows participants to propose, in a coordinate manner (taking turns, similar to the system used while generating ideas), groups of ideas based on any given instructions. Then, participants can vote for groups of ideas, and the moderator can decide to accept them or not. It should be noted that there can be an analysis stage with only one of these actions and a second analysis stage with another action, or several actions can coexist in an only analysis stage.

*3) Idea relation stage:* each participant, based on existing ideas (possibly already purged, after an analysis stage), can analyze ways of relating them and puts together a relational map that can be exported and sent to the moderator. This type of strategy was selected for this stage to allow the teacher to analyze each student's ability to relate ideas. Thus, the teacher knows how individual students were able to perceive the topic being discussed. We believe that individual work is important at this stage, so that students have time to elaborate, relate and, thus, provide other, additional information to the teacher for later work with the group of students. The moderator can add or not one of these stages to the session.

*4) Results stage:* this is a fixed stage and is always the last stage of a session. If there was a voting process, ideas are sorted, in an ascending or descending manner, based on the number of votes received and shown to all participants. Various sorting and filtering criteria can be applied for viewing the ideas. Filters can be by participant or by idea (e.g., view only votes for a given idea). If both filters are applied simultaneously, the results show one participant with the number of ideas contributed and the number of votes each of these ideas received.

### C. Decisions regarding collaborative system features

*1) Awareness:* a notifications system was defined that uses color- and sound-coded pop-up messages to alert participants of various situations. For instance, when moving from one stage of the session to the following one, or when a participant proposes a group of ideas based on some criterion during an analysis stage.

*2) Collaboration:* this feature is strongly present throughout the session, for example, during the contribution of ideas by all participants, or when grouping ideas during the analysis stage, among others.

*3) Coordination:* to determine the tasks that each user will carry out, and when they will do so, STORM offers a turn request/granting system that is controlled by the moderator of a session. Turns are particularly important in the idea contribution stage, if it is done synchronously. It is also important when analyzing the ideas, allowing different participants to propose groupings and the others vote if they are in favor of or against the proposal.

*4) Cooperation:* cooperation is present during the individual stage of the system (idea relation stage). Participants relate the ideas, following instructions, and thus cooperate in the relation task. Then, the teacher can compile all relations to create a final relational map or scheme and share it with the group.

*5) Comunication:* communication is essential for the development of a Brainstorming session. Therefore, STORM offers synchronous, text-based communication while the session is taking place, and asynchronous communication through an internal messaging system. This is one of the aspects that will be enriched in future versions.

## V. ASSESMENT OF STORM

Various tests were performed on the system. These were carried out with the developers, on the one hand, and with people from various disciplines and educational levels on the other. The first sets of tests were system tests to detect possible operation errors, and they included the simulation of various work scenarios with the system. The second sets of tests were aimed at analyzing not only the functionality of the system, but also usability-related features. Testers were Computer Science and Educational Sciences professors and professionals. Also, a use experiment with teenagers was carried out. As part of the assessment, after each test session, participants feedback on the system was collected (this was done by means of feedback reports or chat sessions with discussion with participants). This showed the aspects that the participants found difficult, and those that they valued as positive. Additionally, the moderator of each test session was an expert in the system and recorded every observable situation that would allow introducing improvements to the prototype in the future. Experiments were carried out in a distributed fashion, i. e., session participants were not in the same physical location. Some worked from their homes, while others did so from their offices or work spaces. Different browsers were also used to test for possible issues with each of them.

The reports obtained from the participants for each session, as well as the feedback collected via chat, were then analyzed, and a document with improvements to incorporate was prepared. Thus, this first version of the prototype has evolved based on the various assessments carried out. The main aspects that were improved were related to some functionality errors that had not been tested by the developers, interface changes to improve usability (the way in which a group of ideas is shown, for example), inclusion of a larger number of notification messages to improve awareness, and some filters for viewing the results.

## VI. CONCLUSIONS

Based on the theoretical studies carried out and the analysis of specific software for the Brainstorming technique, an opportunity space was found to design a prototype in this area oriented to the educational context.

The application STORM was designed and implemented, with a set of features that are considered to be desirable.

Finally, a series of experiments were carried out using the prototype, which was an essential aspect for its evolution. These experiments allowed improving graphic and functional design aspects, based on the feedback obtained from different student and teacher users from various educational scenarios. The prototype is under constant evolution based on its use in specific contexts and the feedback from participants.

Based on the work done so far, some future lines of work can be proposed. Some of these are improvements to the prototype proposed, while others are related research and development lines. Among them, the following can be mentioned:

### *A. Videoconference*

It allows participants to communicate through voice and video in addition to the text communication that is possible through the chat tool. This functionality is of interest when session members are working at the same time but in different physical locations.

### *B. Sending notifications to external e-mail boxes from the aplication*

Another option to follow the brainstorming session without the need of having the application open, is receiving news by e-mail. This is a very useful option both for active participants and observers, in particular in the case of asynchronous sessions.

### *C. Ubiquity*

Extending the application for use in different mobile systems.


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## REFERENCES


[1] A. Barker, 30 minutos para hacer brainstorming y generar ideas geniales, Ediciones Juan Granica S.A., Barcelona, Spain, 1999

[2] N. Burbules, T. Callister (h), Riesgos y promesas de las Nuevas Tecnologías de la Información, Buenos Aires: GRANICA-Educación, 2001.

[3] M. Area, Los medios y las tecnologías en la educación, Madrid: Pirámide, 2004.

[4] L.M. Bibbó, Modelado de Sistemas Colaborativos, Thesis report presented at the School of Computer Science of the National University of La Plata to obtain a Master Diploma in Software Engineering, 2009.

[5] J.M. Carroll, J. Hao, M.B. Rosson, Shin-I, Jing Wang, Lu Xiao, Dejin Zaho, Supporting activity awareness in computer-mediated collaboration, International Conference on Collaboration Technologies and Systems (CTS), 2011, pp. 1-12, print ISBN: 978-1-61284-638-5.

[6] N. Galdámez, C. Baquedano, C. Sanz, A. De Giusti, Diseño de un entorno web colaborativo que de soporte a la técnica de Brainstorming Graduate Thesis, available at the School of Computer Science, UNLP, 2011.