E-BRAINSTORMING: OPTIMIZATION OF COLLABORATIVE LEARNING THANKS TO ONLINE QUESTIONNAIRES.

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ABSTRACT

The purpose of this article is to present a methodology and tools allowing the use of online multiple-choice questionnaires to enhance collaborative work. The first goal is to allow the questionnaires generation and setting with a simple and ergonomic manner, but also to let questioned people making comments and proposing new questions to other contributors. The developed system provides a visualization of a synthesis of the questionnaire results that is also accessible by the mean of external applications through standard Web services. These principles were developed and tested on a sample of users.

KEYWORDS

Collaborative learning, opinion poll, collective intelligence

1. INTRODUCTION

The interest of the co-operation between individuals is not any more to demonstrate. In many aspects of the everyday life, the co-operation enhances innovation and makes it possible to solve problems that are out of individual capacity. An example of this type of mechanisms is that of brainstorming meetings. In these productivity meetings, the individuals generally meet themselves physically. This bodily localization plays a significant role to facilitate the exchanges organization and the formalization of the group's consensuses. In this context, the role of organizer who formalizes the group's expression is often held by the regulator of the meeting. The transposition in the computer-mediated field of this kind of meetings poses several problems, particularly in relation with the exchanges a-synchronism and with the availability of the organizer. In the case of low availability, a part of the regulator's role goes back to the group. The difficulty in this case lies in the making of the synthesis of the collective contributions, which can be expressed in a disordered way without the active regulator involvement. Examples of this extreme case can be found in electronic forums discussion (e.g. Usenet News groups).

In this context, the use of a multiple-choice questionnaire (MCQ) can be an answer to channel the participation of the group. This approach makes it possible of simplifying the synthesis of the opinions, which in fact is carried out by the statistics of the answers. The consensuses or the divergences can be identified in the following way. For example, we may observe that 50 % (divergence) of the contributors agree to work on Saturdays but that 99 % (consensus) think that, in any case, the manager should not impose

this decision. The problem of this approach is that it limits the co-operation and sometimes bias the results since the contributors do not have other choices that those being proposed by the questionnaire. We considered two solutions to these limits. The first consists in offering, in addition to the choice of answers, for each question, a zone of free comments and then a zone of global comment at the end of the questionnaire (see Fig 2 and 5). The second solution consists in giving the possibility to each contributor of adding his own questions and multiple choices of answers to the main questionnaire. In this way, the user, according to his inspiration, simply, chooses an answer into the initial MCQ or proposes new questions. In this approach, the users implicitly make a quality selection in the questions while not answering (notch the box "the question is badly formed or does not interest me") or while answering the questions which seem most relevant to them. A question that will have been the subject of many answers (non-null) will be better ranked than others. This classification will allow identifying questions that are more relevant. From the same manner, questions with many comments imply a special action (clarification, highlight subject to debates, etc). We may compare this situation with social dynamics, for example, within corporations. When social disorder appears (e.g in economics difficulties period), trades unions become very actives and publish leaflets more than usual.

Our approach is based on the principle that a "formulated" problem is as half-solved. We use the intelligence of the group here, not only, for answering the problem, but also for formulating it. Let us notice that we exploit a kind of circular cooperation (Lancieri, 2004) because some individuals will be ready to add new questions and others simply to answer. This technique transposes the principle of brainstorming in the electronic world. Actually, the electronic forums could be used in computers-mediated brainstorming meetings, but they would require active regulators for channeling and synthesizing the creativity of the group. In our approach, the conjunction of the users' closed questions (MCQ) and the easy management of the answers automatically channel the creativity of the group. This emphasizes the most relevant questions, and associated answers. Our system also allows to each user to launch his own initiative of online brainstorming by generating his own startup questionnaire, even in situation of mobility by the intermediary of a PDA or a mobile telephone.

This method can be applied to many contexts implying cooperation between individuals through computers networks. Within communities (corporation, groups of affinities on the Web, etc), this process is particularly useful and cheap in the case of geographically distributed communities. It also allows to spread out the brainstorming in a large time period and simplifies the evolution of the problem understanding. This is another example demonstrating that technology can changes the spatiotemporal interactions between individuals. The electronic vote can also be an interesting use of this technique. Apart from corporation context, this methodology can be also applied in the open Internet to facilitate customers' opinions feedback while guaranteeing an optimal exploitability of the results. In an e-learning context, this process can be used to support the training while making it possible to the teacher to understand better what is not clear for students. This can be automated by highlighting questions with many comments. Moreover, the MCQ optimization is easy to manage, and finally consists in building the most relevant questionnaire by the contributors' cooperation. This MCQ can also integrate multimedia data, as images (see figure 2).

This article starts by describing the various technical modules of our system as well as some results in terms of ergonomics (man-machine interface) and some feedback of uses. We present then, a state of the art of related works before starting a discussion on the advantages and the limits of our approach.

2. SYSTEM DESCRIPTION

The E-brainstorming system describes an ergonomic method to manage online questionnaires. Taking as a starting point the forums (Usenet, PhpBB, etc), this process is original since it integrates a specific management of interactions:

- Easy generation of the online questionnaire starting from a simple user script.
- Ergonomic addition and removals of each questions/answers set.
- Possibility of online view of answers synthesis (statistics, graphs, etc)
- The management of the traces (chronology, subset of answers, etc.) allowing to evaluate the phenomena of collective intelligence.

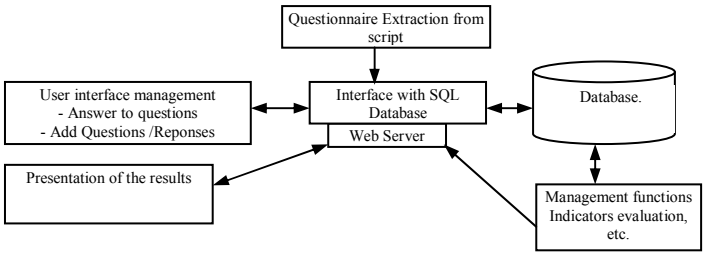

Figure 1: Functional architecture

The various modules of this architecture are described as follow. At the initial stage, the questionnaire can be generated automatically by extraction from a simple script, as shown below. Let us imagine that a user, in the train, sends an e-mail (from a PDA or a mobile phone) to the system. An example of this kind of script is represented in table 1. The user transmits his mail to the generation module that automatically creates the online questionnaire user interface. In return, the system send back details on the operations achievement (error, success, etc), as well as the URL where the questionnaire is accessible. The user may then send an e-mail to his correspondents to ask them to answer the questionnaire. The figure 2 shows the user interface corresponding to the script (table 1) as well as the answer and the user's comment. Let us remark that the second question (Do you often use your e-mail?) is willingly imprecise in order to show, in the next part of this paper, how it is possible to correct it (figure 4).

Table 1: Exemple of user script

T- *Usages of communications tools*
I- *Telephone.jpg*
Q- *What is your favorite communication tool?*
R- *Telephone*
R- *Mail*
R- *Chat*
Q- *Do you often use your e-mail ?*
R- *Yes*
R- *No*

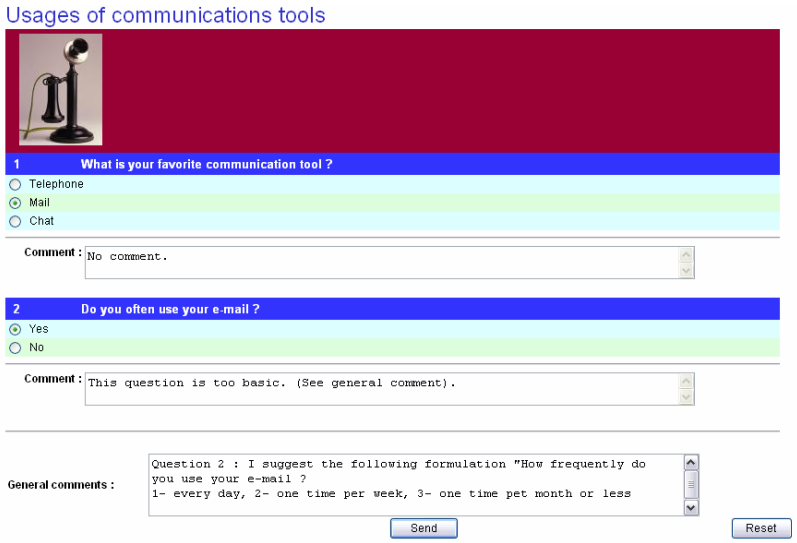

Figure 2: The user interface corresponding to the script (table 1)

Contrarily to basic usages, where tag based scripts (XML, etc) are supposed to be created and used by computer processes, in our case the script is an interface between human and computers. Consequently, our script approach needs to optimize the expressiveness with the constraint of simplicity for the user. Thus, we propose mini tags, where only two are necessary (Q- and R-), which identify the question and the answers. Other optional tags can be used (category of questionnaire, titles of sections, images link or URL, etc) in order to enhance the expressiveness of the user interface. An interpreter module converts and verifies the coherence of the script. A table is created in a SQL database starting from the script, which will be also used by the interpreter to generate, on the fly, the Web user interface integrating the questions or the results. An online help can be added to each question, in the form of information-bubbles, but each question has also a link toward an interactive structured FAQ.

The extraction module is composed of three functions:

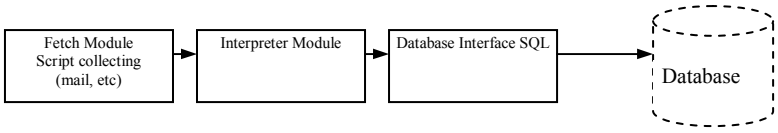

Figure 3: Structure of the extraction module

The script can be transmitted, in a nonrestrictive way, by e-mail (basic scenario), written on a Web form, etc. The interpreter module takes into account the various tags and generates a configuration file used to create the questionnaire interface. The users' answers and comments are stored in a SQL database, but not the questionnaire itself that is stored in the configuration file. This file created only one time, avoids the script interpretation at each user connection and consequently reduce the processing time.

We investigated three modes of MCQ user interface corresponding to different levels of interaction complexity. The first mode corresponds to a static questionnaire with a stable set of questions and associated possible answers. In this mode, the users have only the capacity to select an answer choice. The second mode adds to the first the possibility for each user to provide comments. The figure 2 shows an example of such interface. The third mode adds the capacity for users to add their own questions and choices of answers. This mode, a little more complex to manage, is largely inspired by the interface of a newsgroup forum. The questions and answers are organized into semantic wires (related questions are connected as posts in newgroups). When the user connects itself, the questions that he did not already answer are highlighted whereas the already answered questions are hidden but can be showed on demand.

While reading the questions, the user can:

- Answers the question via the questionnaire (choice of appropriate answer). (As in mode 1)
- Selects the item "the question is badly arranged or does not interest me", or adds a comment, for example to specify his answer. (As in mode 2)
- Adds a new question, wired (i.e. in relation) to the initial one. The same interface is proposed to enter a new title, the new question, and the new possible answers. (See figure 4)
- Decides to answer later when the debate has advanced. In this case, this question will remains highlighted in his list of questions.

The following figure shows the user interface look and feel in the third mode. The part A of this figure shows the wire of questions where as the part B shows the selected question on the wire. When the user selects the item "new question" (B2), the new user interface allows adding the elements (question and answers) of the new question. The part C shows a new question in course of building. At this stage, the user is adding the third possible answers (C2) to those already written (C1). When clicking on the button "inserts new answer", the new answer will be added to C1 and the field C2 will remains free to add another new choice of answer. When the set of answers is completed, the set of question/answers elements is integrated in the wire by clicking on the "post" button.

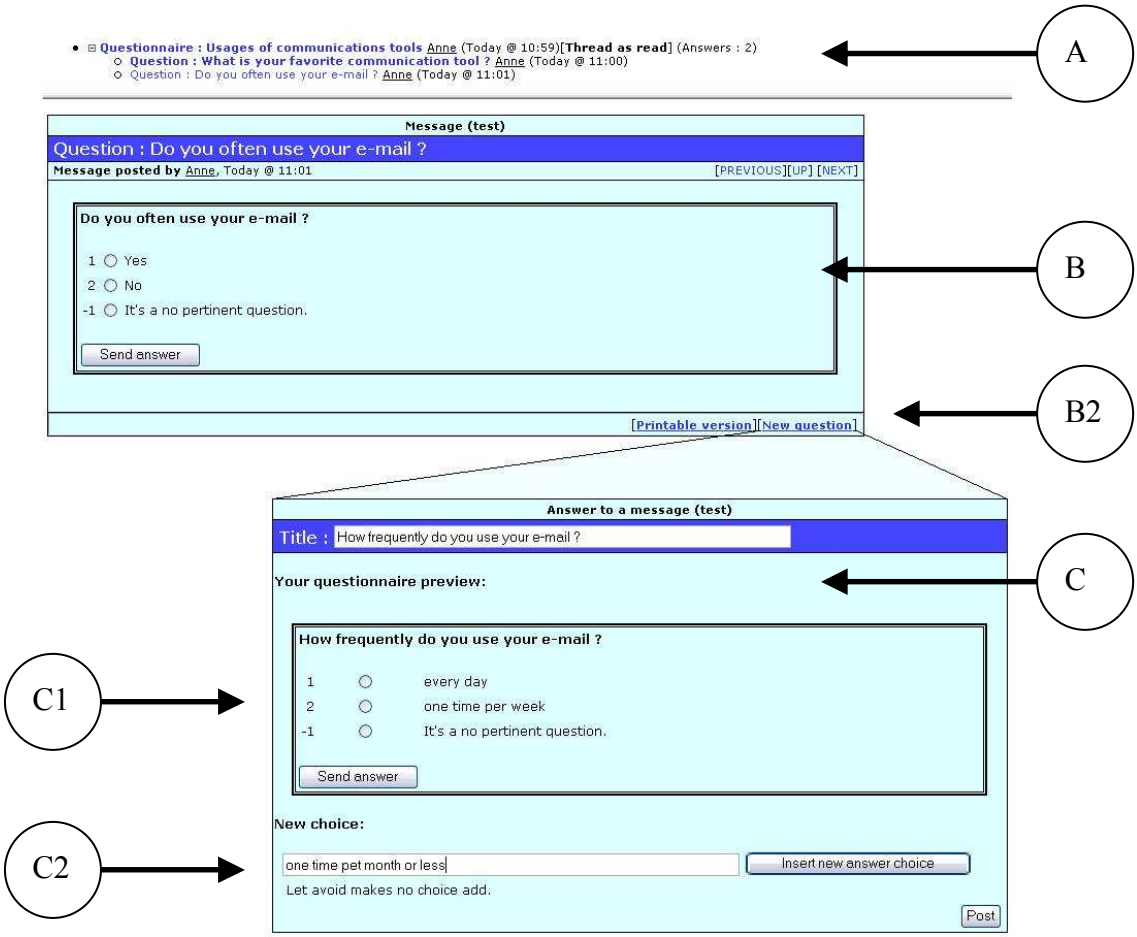

Figure 4: Adding a new set of question/answers to the MCQ in full interactive mode.

As said in the introduction, one of the most significant advantages of this MCQ approach is the simplification of the results synthesis which are automatically managed and presented to all the users in the form of statistics (see figure 5). In classical cases, with several questions, results are presented, one after another, in the same web page or separated according wires.

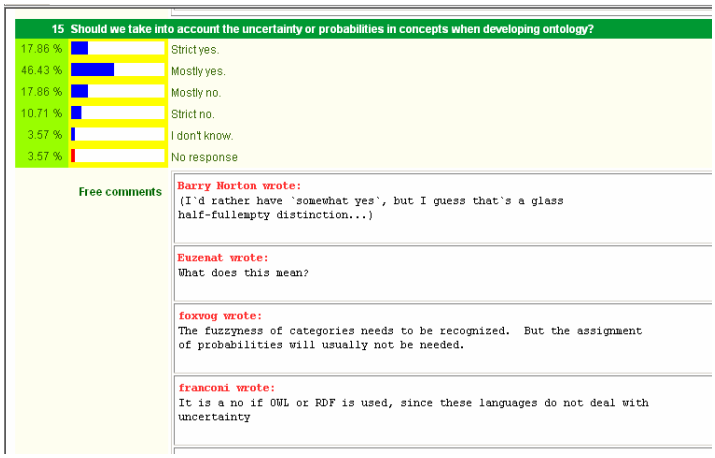

Figure 5: presentation of the results.

When a user answered the questions, it can display the results as well as questions relevance classification. The calculation of this ratio is carried out by the management module (see figure 1) and can be computed in several ways, depending, for example, on the number of non-null answers ("non pertinent question" see figure 4). The user can thus quickly have an overall picture of the debate that took place, and deliver his opinion while answering the questions identified as most relevant. The users' answers, comments and statistics are stored in a database that also contains (as in a standard forum) users' information (for accounts and connections management). The interrogation, the insertion and the management of this database are carried out via SQL. This principle makes it possible to interface our system with other Web services based applications. This allows interoperability and services extension toward, for example, information search engines, e-commerce or e-learning services. These services extensions are mainly based on the reuse of statistical results.

3. STATE OF THE ART

The exploitation of the phenomena of collective intelligence represents a challenge in the fields of computer science and cognitive sciences (see Lancieri, 2004) for a synthesis of the theoretical aspects covered by this question). This section provides some examples of concrete applications of these phenomena close to our system in order to highlight the main differences.

An online forum can be used as a basis for an electronic brainstorming. The problem is that the discussions often deviate from the initial issue and raise other questions. If there are many participants, it becomes very difficult and time consuming to make a synthesis of the results. Moreover, an active moderator is often necessary to regulate the exchanges. Many forums (e.g. PhpBB, AceBoard) propose to add an opinion poll to a discussion wire. This option makes it possible to associate with the first message, a question and a choice of possible answers. When a user answers the opinion poll, the results are posted but only the author of this first message and the moderator are allowed to modify this opinion poll. Moreover, there is only one possible question per wire. If the question causes a debate, it will have to be exploited manually from posted messages, by reading all the answers of the wire. This is the only way to take into account, amongst other things, opinions changes.

A wiki (e.g. Moni Wiki, MediaWiki) is a collective Web site where it is easy for each user to modify the pages. Collaboration is open as in a forum (possibility of adding comments). Several Wiki also propose an opinion poll option, sometimes dynamically, but as in the case of forums, the questionnaire management is often too simple and corresponds to a small part of the collective contribution.

With regard to the automatic generation of questionnaires, the first attempts to integrate forms into HTML pages began in 1993. More recently, the XFORM W3C (XFORM) standard based on XML proposes a set of questionnaires representation modes (adapted tag, etc). About thirty companies (e.g. IBM, Oracle, SUN, Pureedge, etc) used this technology (see XFORM implementation). SUN, for example, used XFORM in Star office forms (see Star office Web site). This approach is interesting because it allows automating the representation and the handling of knowledge necessary for the use of questionnaires. Unfortunately this formalism, if it is well adapted for a processing by machines, does not fit well to human direct use. The main reason is related with its high level of formalism (i.e. XML based). The generation of such forms thus requires specific software as man-machine interface where an individual inserts the questions and is not worried with formalism (e.g. Macromedia Cold Fusion (see Cold fusion Web site)). Our proposal aims at limiting the formalism in order to help individual to remember easily the script tags elements.

From a general point of view, the idea to propagate a questionnaire on the Net is not recent. Several studies were made on the principles and practical aspects of this question (Chou, 1997) (Mohen, 2001) (Lauer, 2004). For example, Padillo et *al* studied the democratic participation in Usenet newsgroup based on 390 newsgroup polls and 117,000 votes (Paodillo, 2002). Some methods propose to the authors to adjust their questionnaires dynamically (Morton, 1995), or propose an advanced interface in order to setup the questionnaires online or to visualize corresponding results (Dennis, 2000). Even if these systems incorporate questionnaires based tools, they often propose a minimal management that needs a strong implication of the authors of the questionnaire: to write questions, to analyze the results by taking into account the free comments. In addition to the setup difficulty, the risk of biases is higher in these approaches because of the

limited sources (only the authors) of the problem expression (questions/answers). In contrary, our approach suggests to take benefit from the collective management.

4. DISCUSSION

The online questionnaires are simple ways to gather a broad population and to make it contribute to clear up problems and to find solutions. This approach is promising for three mains reasons. Firstly, it offers an implicit management mode of interactions which focuses on the major aspects of the problem, and which limits drifts as they can occur with other technologies, like forums. This directed reduction of the knowledge space can be connected with the positive aspects of lapse of memory in the human cognition processes, which contributes to the phenomena of individual and collective intelligence (Schacter, 2002), (Lancieri, 2005). The second positive aspect is related to the fact that this method makes it possible to formalize in a structured way the possible problems and answers. Not only, it is possible to obtain, in a statistical way, the answer to a question but, it is also possible to integrate it in a structure of knowledge (XML, RDF, OWL, etc) which supports a posterior exploitation by information processing systems (Web services, semantic Web, etc). This is impossible with open debates as in forums newsgroup based technology. The third point relates to the simplicity of the organization and of the use of MCQ based spaces of collaboration. With our approach, the questionnaire can be published and installed online, in few minutes. This can be done from any place of the planet, starting from a simple PDA or a mobile phone. In our experiment, 90 % of the answers were obtained within the 24 h following the online survey setting (warning users by email).

An other important question to consider relates to the quantitative level of answers, as well as the implication of the contributors. We considered this point according to the three modes of questionnaire interaction mode: the simple MCQ where only the answer choice is awaited, the annotated MCQ where in addition to the answer the user can make comments, and finally the total participative mode, where all the users may add questions and propose answers.

The first mode requires little investment of the user who needs just to click on predefined choices. On the second mode, the user slightly redirects the choice of the organizer by making comments. On the third mode, the users place themselves on the same level as the organizer by proposing their own questions. According to our observations, this last mode seems to be appropriate for a limited population who feel themselves deeply involved in the debate or the problem to be solved. In order to have a first evaluation of our approach, we tested it through two questionnaires. The first one devoted to the best practices of web semantic technologies is composed of 38 questions. The second one devoted to the use electronics forums is composed of 35 questions. Globally, for the two questionnaires, on a population of 300 persons (including participants to a European project and a population of engineering students) potentially concerned with the debates and contacted by email, only 89 persons connected themselves and answered the online questionnaire (30%). On this population, only 17 persons made comments (19 % of answerers). The population having proposed questions and answers was not evaluated formally, but it can be estimated by the content of the comments. On the 17 persons who made comments, only 6 made very deep and long remarks (indication of their implication) (6.7 % of answerers) whereas the others made simple remarks (encouragements, general and short feedback, etc). Let us remember that the fact of proposing new questions implies particular efforts that are not ready to make all contributors.

In the continuation of our work, we will improve our experiment within a wider population. This will allow evaluating better the effectiveness of this approach having enough people that add new questions.

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