Quest, a telematic tool for automatic management of student questionnaires in educational research

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Abstract

This paper presents the design of *Quest*, a telematic tool that automates the management of student questionnaires that serve to collect the basic data for our educational research. The aim of the tool is to make easier for the students to fill the questionnaires and to facilitate the researchers to process the answers with qualitative or quantitative software packages. The tool is then offered through the WWW, with a client-server design. The telematic design is constrained by the fact that the response time should be limited for the operations carried out by the students, and independent of the number of students using the tool, which in turn requires to reduce the traffic over the network. *Quest* has been used for a semester in our educational research, providing more student satisfaction, which improves their implication with the research, and reducing the burden on the researcher to process the collected data.

1 { TC }Introduction

Educational research, as other social sciences, is primarily based on the analysis of field data (Liston and Ziechner, 1993). Our approach to evaluation is based on the principles of *classroom-based research and development* (Stake, 1995). This approach draws on naturalistic research methods able to deal with the subjective and complex nature of the studied phenomenon. In particular different types of data are collected in the classroom with the actors of the teaching/learning process. For example, the researcher can directly observe the classroom, reporting his subjective impressions about the educational process (Liston and Ziechner, 1993). This process is costly because the researcher must be present in the time and location where the process takes place, and therefore is not suitable for distant learning (Fox, 1980; Neale & Carroll, 1999). Another way to collect data from the educational process consists of asking the students to fill questionnaires (Rodríguez, Gil y García, 1996). This method can account for students subjectivity through open questions, which is relevant to the researcher in order to compare the impressions of the different actors, but adds the need of a treatment of these data by the researcher, which can result in a tiresome process that includes the manual transcription of students responses to electronic format for its later processing. In addition to how data is collected, educational research must analyze the data, by either quantitative or qualitative (Rodríguez, Gil & García 1996) procedures, as convenient. Though there exist tools that facilitate this analysis, the combination of several of these tools and the data collected is often difficult because of the heterogeneity of the data, and the different formats used by the tools.

This paper presents *Quest*, a new telematic tool to manage questionnaires used as a source of data to carry an educational research. Together with existing tools, it will allow a rather automatic application of a mixed (quantitative and qualitative) evaluation of the educational process. *Quest* serves for an easy questionnaire generation by the researcher, collecting students' answers, and processing them to feed several analysis

tools. Once the questionnaires have been defined, students can fill them from any point accessing the Internet. Moreover, the tool is also employed within the courses as an educational resource, to fill forms about the contents of the course, which are collected by *Quest* and organized in tables that any student can consult. Finally, since all activities of the students are logged by the tool, *Quest* itself can provide useful data such as which tables are the most visited, or if a student is especially interested in the answer of some other student. These data can be used by the researcher, together with other tools, to evaluate the educational process.

The rest of this paper is organized as follows: section 2 presents the educational research project, that motivated the design of *Quest*, and will serve to evaluate its utility in a real environment; section 3 will describe the design of the proposed telematic tool; section 4 will discuss the benefits from this tool, summarizing the main conclusions and outlining the future work.

2 The educational research project

2.1 The educational setting

As mentioned above, we draw upon the principles of *classroom based research and development* (Stake, 1995) to conduct our work. For two years we have been involved in the introduction of project-based learning with case studies in a course for a degree in Telecommunication Engineering. Therefore, we are working in the definition of an evaluation methodology to support the assessment of how the concepts and attitudes towards collaboration of the students develop as a result of their participation in the course. To show why *Quest* becomes useful, we will briefly describe the educational setting, and outline the main ideas of the methodology as they regard to the design of *Quest.* More information about the educational setting and the research project can be found in (Dimitriadis et al. 2001) and (Martínez et al, 2002).

The course is split in theoretical lectures in a traditional classroom, and practical work in a computer laboratory, where students can use several computer tools and simulations. Students are grouped in pairs and faced to a case study, which is in turn split in three *subcases*. Five different case studies are proposed, so that not all students have the same one. Each *subcase* has an intermediate and a final milestone, in which students have to answer a form with questions about their study. All these answers must be collected, unified in some way, and exposed to the whole student community, so they can observe each other's answers, and find out general trends, exceptions... Some time after this data is made public (usually a week afterwards) a discussion is held among the students and the teacher, concerning these contents. In addition, students have to provide a written report by the end of each *subcase*.

The pedagogical design has been supported by several telematic tools, including *BSCW (Basic Support for Co-operative Work)*, a robust software package (GMD-FIT, 2001) that provides asynchronous document sharing and threaded discussions. BSCW records data logs registering every action performed on the shared workspace, which were used as a source of the analysis, as explained in the following section. In addition, a *synchronous debate organizer* was used to collect student answers to questionnaires on the course contents, and publish tables with the collected responses. The tool presented here can be used for this purpose, besides supporting the educational research. In fact,

using *Quest* will yield two indirect benefits: on one hand, students use the same tool for the forms on course contents that for the research questionnaires, which makes easier for them to participate in the research; on the other hand, we may observe their interactions through this tool, resulting in a new source of data for our research.

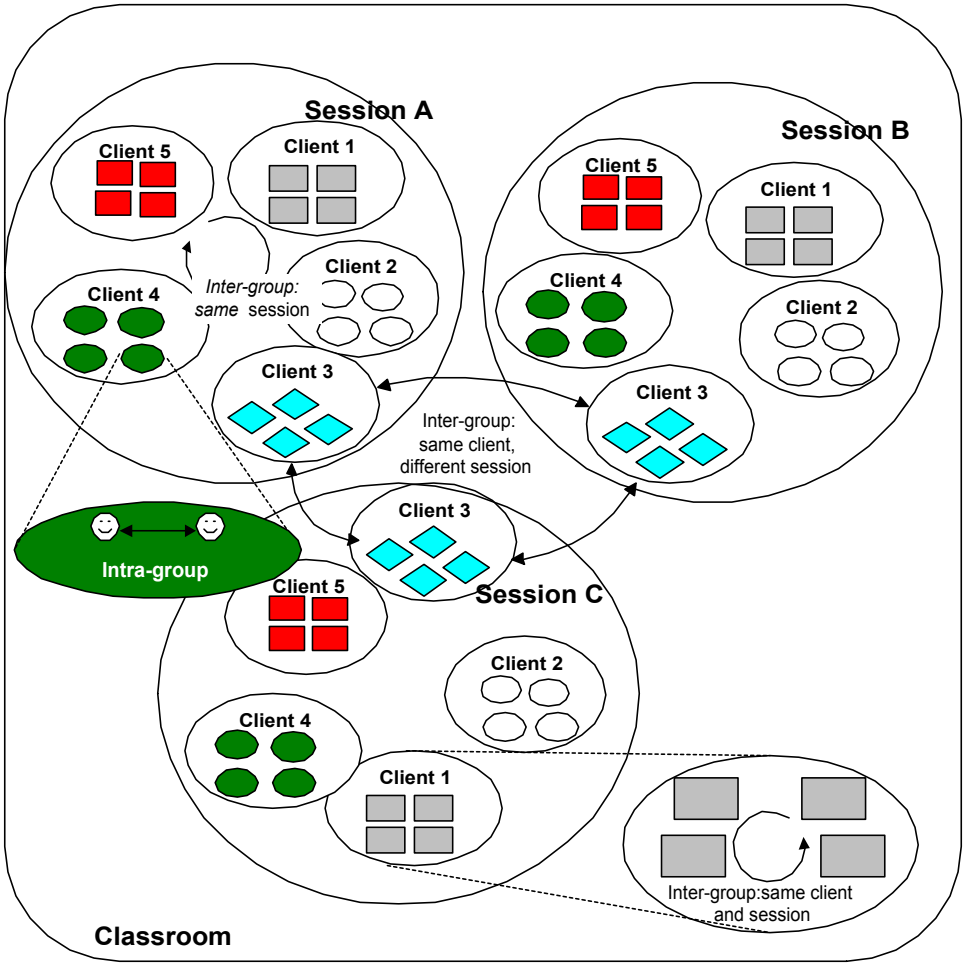

Figure 1. Logical organization of the classroom in our educational research project. Students form pairs, and *intra-group* collaboration can occur within the pair. Each pair is devoted to a case study, called a *client*, and therefore, pairs with the same client usually collaborate more. In addition, students collaborate with others with different client, that may be or not in the same laboratory session.

As part of our educational research, we have designed an evaluation methodology that aims both at the study of the development of concepts and ideas towards collaboration by the students, and at the formative evaluation of the course itself. We aim at the integration of two analytical approaches: qualitative analysis of ethnographic data, and social network analysis (SNA) (Scott, 2000), a set of procedures that focus on the study of interrelationships within groups. However, to collect the data for this evaluation, we must consider that we are dealing with a semi-presential setting, in which students can collaborate in several moments and places: at the laboratory during normal sessions between one student and his partner, or with other groups; indirectly by sharing information such as documents in the BSCW space, or answers to questionnaires on course contents; publicly at the discussion sessions by commenting the answers; outside the university during the preparation of the report... Figure 1 depicts the possible interactions between individual students or groups of them.

2.2 Data collection and processing

In order to explore all these forms of collaboration, we are using a variety of sources of data, including interaction logs from the computer, and data of ethnographic nature, like formal observations, interviews and questionnaires. In particular, questionnaires are used in order to collect the subjective impressions of students about collaboration. In order not to disturb them much, the same tool that is used for the forms on the course contents can be used. However, this tool must satisfy certain constrains derived from the peculiarities of the educational research.

Most of the questions asked to the students will be open questions, which may be answered with remarkable subjectivity, and will therefore be processed through qualitative analysis tools. In particular, we have been using Nudist (Fraser, 1999). Despite the convenience of this tool for the research, in our previous experience we found ourselves restricted by a strong burden of preparation of the data, including the collection of every student's answer to a given question into a single *Rich Text Format* (RTF) file, and possibly other data about the students. This can be done easily by *Quest*, once the answers were collected in a database.

In addition to this type of questions, others involve quantitative or statistical evaluation, as for example the number of hours devoted to one given task, or the distribution of answers to a multiple choice question. The Quest tool can do this itself, or alternatively, it could format the data as suitable for a spreadsheet utility.

Finally, as mentioned above we want to study the collaboration interactions through telematic tools. For this purpose we can use event logs provided by the tools that show the use the students make of it, and how they communicate with each other or share information. When *Quest* is used to support the questionnaires on course contents, and tables made upon them, all the accesses to any piece of information provided can be recorded. These logs are processed with social network analysis tools, as EL2AM (Martínez et al., 2002b), in order to elicit the (indirectly) established interrelationships.

Besides these requirements for the telematic tool, that concern the needs for data and its processing, it must feature other properties: it should allow fast and easy creation of new questionnaires by the teacher or researcher, and as flexible and easy management of the collected data. In addition, it should be simple to use by the students, and independent of the fact that the students are on their assigned computer in the laboratory, or elsewhere, as well as independent from the number of students answering their forms at a time.

3 Design of a telematic tool to manage questionnaires and answers

In the previous section we described the needs concerning collecting and processing data for the educational research, along with other requirements. It is easy to see that three types of actors are involved with the tool: the researcher, the teacher of the course, and the student. In addition to these actors, we may identify a system administrator in charge of cleaning the database, making backup copies... but we will ignore this here. The three actors involved with the tool will demand different services from it, as shown in Figure 2.:

- The researcher starts by designing questionnaires, and making them public. After they have been answered, he wants to process the data, which may imply: generate

files suitable for the analysis of open questions with Nudist; or generate statistics or a spreadsheet for numeric or multiple choice questions; or generate input files for EL2AM with explicit questions on relations among groups, or data from students access to tables made of answers to course topics.

- The teacher wants to design forms on the course contents, and make them public. These answers will be included afterwards in tables for the students to consult.
- Students want to answer the researcher questionnaires and the teacher forms, in a similar and easy manner. In addition, they want to search the tables created by the teacher after their answers to course topics, and possibly create their own tables, that include only data more relevant to them.

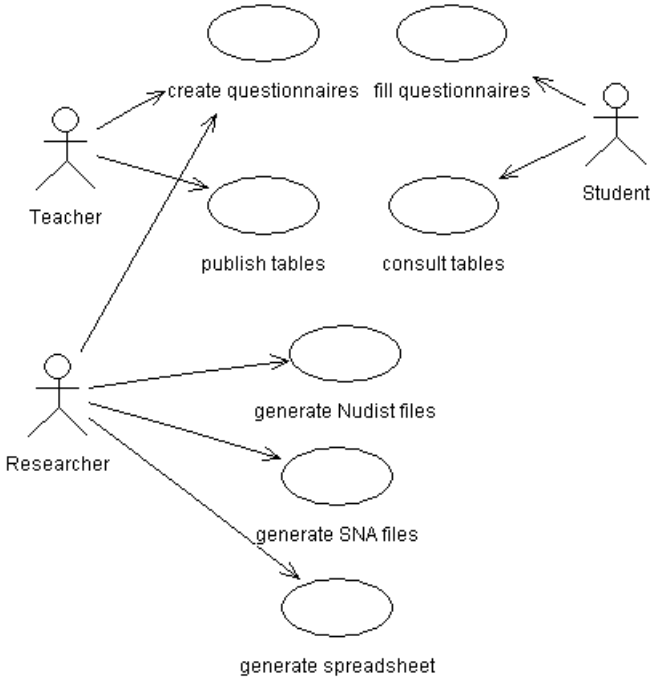

Figure 2. Use case diagram that describes the interactions between the three possible actors and the telematic tool *Quest*.

In addition to all these functional needs, there are some performance restrictions. First, the tool should be used indistinctly at any point of the Internet, so the students can answer the questionnaires or consult the tables from the laboratory, other place in the university, or their homes, and the teacher or researchers can work similarly at their offices and other places. This suggests the tool to be offered as a collection of hypertext pages along with some functionality, i.e. *web application* located at a web server, and accessed from client machines in the Internet. Since these client machines may be heterogeneous in resources, it is recommended that most of the computation is performed at the server side. Moreover, the restrictions on response time should be placed in the operations carried out by the students, since long waiting times will discourage the use of the application, thus resulting in a lost of valuable answers. This restriction not only implies student operations to require little computation time, but also reduced traffic over the Internet. It is noteworthy the time after each subproject discussion, all students are invited to fill out a questionnaire on the work carried so far, and therefore a large number of accesses to the *Quest* server will take place in the same local network.

This requirement was strongly recommended by our experience with similar tools (Dimitriadis et al., 2001). In previous experiments we used a tool like to *Quest*, but with a inefficient design, that put most of the computation on the client side, and transmitted large quantities of data, resulting in performance degradation as soon as a few students were using the tool. The fact that students find this method easier and faster can contribute to increase the sincerity and implication of the students in the process. As a consequence, more questions and hence more data can be collected, with increased reliability.

All these restrictions suggested the following design:

- The teacher or researcher may design a new questionnaire by either a visual tool or a text file with a given syntax, similar to the LaTeX text formatting package (Lamport, 1994). Currently only the second option is implemented. The questionnaire may be organized in sections, each with an opening text and several questions. The questions may be open (free text or numeric), single or multiple choice (one or several among predefined options must be selected), and matrix questions (which are simply matrices of questions of the above types) that can be used for compactness.
  When the teacher is satisfied with the questionnaire, an HTML form page is created with it, and it is made public.
- To answer a questionnaire students only need to see the HTML form and fill it. Their answers are collected by a server routine that simply stores them in a database, without processing them. This implies little traffic over the network, and little computation time, which ensures a small response time to the students, independently of the number of them using the tool.
- Eventually the teacher or researcher will determine the time to fill the questionnaires is over, and *close* them. This will stop Quest from collecting more student answers.
- If the form was on the course contents, the teacher will publish tables. The tables are created by consulting the database and creating HTML files, which become public. The students may then consult the created tables, generating very little traffic over the network, and computational burden to their machines. They could also generate their own tables, which has a longer response time because the database has to be accessed, but since all the computation is carried out at the server machine, little traffic is added to the network and the performance for the rest of the users does not degrade. All the accesses students make to existing tables or those they create are logged, and may be studied by the research to understand student interactions.
- If the questionnaire was for the educational research, its answers can be processed by the researcher. He can select a number of them and generate RTF files with a format and contents suitable to Nudist, in order to perform a qualitative analysis. In addition, it will format answers or the interaction logs to produce files suitable for the social network analysis with EL2AM (this utility is considered in the design, but not yet implemented, and thus is now hand made). Finally, the answers can be put in a spreadsheet so statistics can be easily found for several questions. Though all these operations require a significant amount of computation, they are completely carried out in the server machine, so the performance of other utilities of the tool does not degrade.

This design was the base for an implementation of the tool as a number of CGI utilities that generate HTML pages, and interact with a PostgreSQL database manager. The server machine was a PC with Linux that runs the web server, the database manager and all *Quest* utilities. All other tools for this educational research project were run in different machines.

The tool was validated in our educational setting, with four groups of 20 pairs of students, that answered six questionnaires on the course contents, and consulted the tables published after them, and also filled ten questionnaires proposed by the researchers about the educational process. In certain occasions about 20 pairs of students were using *Quest* at a time, without noticeable degradation in performance.

4 Conclusions and future work

This paper has described the design of *Quest*, a new telematic tool for the automatic management of questionnaires, that are useful to collect students' impressions on the educational process, hence becoming a basic tool for the educational research. We have been using *Quest* along the fall semester of the 2001/2002 academic year, the third devoted to educational research on collaborative learning in a Telecommunication Engineering course, and the benefits found over our previous experiences are many.

First, students feel comfortable to fill out the forms, as opposed to previous means for this task. These included paper forms, which are slower to fill, and e-mail forms, which are not visual and required a strict format. We also found a small response time is important (so that the questionnaire is downloaded quickly, and once answered the server also collects the answers quickly), which requires a careful telematic design. The fact that students find this method easier and faster helps to involve the students more in the research. Therefore, more data can be collected, and questionnaires can be done at several moments *during* the course, and not at the end or after the course.

In addition, it largely reduces the burden imposed on the researcher to format and process data. In our research reported in (Martínez et al, 2002), about one fourth of the efforts using Nudist to perform a qualitative analysis of the educational process were devoted to preprocessing and formatting the available answers. It is clear that the simple fact that answers are collected in a database opens a broad range of processing possibilities, not available if data were collected on paper forms, or even unformatted electronic forms. But in addition, we have determined a number of software tools to support our research, such as Nudist or EL2AM, and provided utilities to prepare the necessary files for processing the answers with these tools. This will encourage researchers to use these qualitative or quantitative analysis tools, achieving higher efficiency and enriching their results.

Quest is also useful to observe the student interactions, through the log of the accesses to the course tables created with other students' answers. These tables actually form a shared workspace of information provided by the students, as BSCW is more explicitly. These interactions can help to study the evolution of collaboration, as we did with BSCW interactions in (Martínez et al, 2002).

Finally, it is noteworthy that this tool has integrated two activities involving filling out forms and processing their answers: those related to the course, which consist of filling

out contents forms and consulting tables, and the activities related to the educational research, that require the filling of questionnaires on the educational process and processing their answers by the researcher. Thus, the benefits of *Quest* also extend to the educational process itself, as a means of evaluation of the students for the teacher, and of indirect collaboration among the students.

Since we designed *Quest* to support our educational research, its actual use has suggested the inclusion of new features. In particular, we are much concerned with the observation of the student activities when consulting the tables on course contents. We would like the students could annotate other students' answers, so several discussion threads could be supported by the tool, which would promote collaboration and allow the researcher to observe it. As this feature becomes more interesting to us, we are studying how to adapt *Quest* more tightly to existing social network analysis tools, in order to automate processing the interactions.

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