Real and Virtual Workshops in Mathematics

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Abstract - It is well known that many engineering students, mainly freshmen have a lack of team work and effective communication skills. It is also apparent that the amazing development of multimedia computer software and communication technologies have made more evident those weaknesses and, at the same time, have shown that many freshman students need to be trained, in order to use more efficiently the computational technology.

In order to overcome these weaknesses we have designed a long term Program in Mathematics organized in stages and oriented to freshman engineering and architecture students.

In the first stage we ran two workshops incorporated to the regular first year Maths course of Engineering and Architecture and developed in the classroom. In both workshops we used cooperative learning techniques and divergent thinking methods. We also have developed a new assessment scheme to evaluate the students' performance.

In the second stage we have offered a special course in Mathematics for freshman architecture students that combines a traditional lecture format with "hands on" student's activities, i.e., by using multimedia resources and Internet tools as an instructional media.

In this scheme of work it has also been very important the just in time interaction between students and instructor.

The Program

In this paper we give a description of a Program in Mathematics developed since 1996 and oriented to first year's students of Engineering and Architecture at the Universidad Técnica Federico Santa María, Valparaíso, Chile. This Program was organized in stages.

First stage

In this stage we have organized and run two workshops incorporated to the regular first year Maths course of Engineering and Architecture. In both workshops we used cooperative learning techniques, divergent thinking methods and whenever possible, computer support [3, 4, 5].

The students were, in both workshops, randomly assigned to groups of five people to work together on the activities. During all the sessions, the instructor was available to answer questions, coordinate and facilitate the team works.

The main objectives of one of the workshops were:

- To assess the effectiveness and quality of the teaching and learning process.
- To prepare and test some didactic materials and teaching-learning techniques that we were going to apply in the second stage of the program ("virtual stage").

During a term period and with one session a week, the work was also organized in stages. In the first one the students proposed discussions and analysis of fundamental concepts and topics taught through in the classes of the corresponding week. Then the students themselves suggested and put forward situations and problems related with those topics and in a team work setting, looking for solving strategies and giving solutions to the problems. Special emphasis was given to aspects such as reading comprehension, algorithms, analysis, synthesis, generalizations and applications in mathematics and other fields. Special importance was given to analyze the students' misconceptions and mistakes found in their proposed solutions.

The main objectives of the other workshop were:

- To detect and promote the development of the potential innovative and creative capacities of the participants.
- To give the students the opportunity to tackle “open” problems as a natural way of introducing them to design and decision-making notions.

The work in the classroom (one session a week) was centered basically in obtaining a creative teaching-learning environment (CTLE) which originated questions and problems to be tackled by freshman students. During the first stage these CTLE covered mathematical areas. The originality of questions stated by the students was always appreciated and stimulated, as well as the creative contribution of strategies and solutions put forward. The personal participation was stimulated through question asking and solution searching, and the team work was promoted through the analysis, discussion and generalization of solutions.

When both workshops were over, interviews were carried out to the participants. They unanimously expressed their satisfaction for the activity and pointed out the convenience to keep it along the career curriculum. Moreover, we observed that the students improved their attitudes towards mathematical courses.

We also have developed a new assessment scheme to evaluate the students’ performance based on the quality and originality of the questions and proposed problems rather
than on effectiveness and accuracy of routine answers. For details and more information about this experience see [6].

Second Stage

In this stage we ran a special course in Mathematics for freshman architecture students, that combines a traditional lecture format with “hands on” student’s activities, i.e., by using multimedia ressources and Internet tools such as instructional media.

Considering that the multimedia software and hardware are still relatively expensive and that not every student owns a P.C. at home, we divided the course in groups of 4 to 5 students, working together as a team and sharing a specific computer belonging to one of them. This way we enhanced peer interaction in a level comparable to that occurring in common workshops. We used a Proxy Server of Web pages located at the central university computer lab. This allowed students to navigate through Internet with the minimal restrictions.

One of the main objectives of this stage was that students using the Nestcape or other equivalent browser, were able to find out or search instructional informations to accomplish their homework and use the e-mail to develope their teamwork in an interactive way with the assistant and other groups of students. The assistant established a direct and immediate communication with the instructor by using mainly the e-mail.

The first year architecture course had 55 students and only 12 of them had a personal computer (Pentium or 486) at home. These 12 students were the “centers” of the different teams. As several students did not have a significative previous experience in using the computers as a mean of communication, it was necessary to train them in order to use the e-mail and Internet browsers.

In the architecture domain we focused the work on the treatment of situations related to the fractal geometry, design and tiling problems.

At the beginning of each workshop session, we communicated, by e-mail, a set of problems (2 or 3) that were to be solved by each group of students. Through this communication system we also repeated the necessary “key” concepts, given previously in class, related to these problems, and simultaneously we incorporated this information in our Web page as extra news. The students had at most 40 minutes to obtain and communicate the solutions of each problem. After a definite time we challenged each group with more complex situations to be solved by using information from Internet and Web pages.

Using the e-mail the process continues as follows:

- The group solves the problem given to them and communicates the obtained solution(s) to the assistant.
- After an specific time interval, all groups communicate their work (finished or not) to the assistant.
- The assistant communicates to each group the solution(s) and work developed by all the other groups.
- Each group sends the assistant their comments about these solutions.
- The assistant sends the instructor all this material.
- The instructor analizes the information and communicates to the assistant and the teams the solution(s) of the problem including the comments of the group performance.
- The students discuss the process with the instructor.
- The students may obtain additional information from the workshop’s Web page.

Some of the difficulties that were found in the structure and functioning of this “virtual” workshop were:

- Different geographic locations of students’ residence, meaning, in some cases, to spend a lot of time moving to a specific “virtual” center.
- To establish a team common work schedule to develop some specific problems simultaneously.
- Absence of host home facilities (P.C.-owners) to work in groups of 5 or more people.
- Computers were not always available in the (temporary or not) residences of the students.
- The different levels of experience in using computer technology.

Some of these difficulties were overcome by a good disposition to work in groups.

At the end of the course, 85% of the student grade will be based on assessment of individual performance (quizzes, tests, etc.) and 15% on assessment of group performance (final oral and written reports, workshop’s participation, etc.).

These final results will be available on line for FIE’98.

Conclusions

As this is a longterm Program, we can give some conclusions related to the work just accomplished:

- Until now the experience has been highly positive and amusing for both the instructor and students.
- We think that this experience also has a positive social impact, because it allows students to share, outside the University, queries and experiences with their peers, in a natural way.
- Considering some of the difficulties just mentioned, we think that the team’ size must be at most 3 in this kind of workshops.
- The “virtual” workshop format requires more initial development time than the “real” workshop format. This fact must be adequately considered to organize this kind of activities.
- For a future work it would be interesting to compare and evaluate the performance of the same groups solving similar problems in the classroom (“real” workshop) and at home (“virtual” workshop).
- We think that this kind of activity could be a realistic way to use computer multimedia resources and communication technologies as an effective tool to enhance the teaching-learning process in a course given in a lecture format.

More information and examples regarding the subjects and problems treated in this "virtual" workshop can be found on the Web page at: http://lecc.mat.utfsm.cl/~taller.
To end up the second stage we will run a Maths course oriented to first year engineering students (2nd term 1998) similar to the one already reported. In this course the computer will be used as a mean of communication (e-mail, Web pages, Internet) and as an operational tool (MATLAB, MAPLE).

We hope to communicate the final results of the program in FIE’99

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References