Experiences in Cooperative Computer Engineering Course at the São Paulo University – Brazil

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***Abstract* - This paper aims to present some experiences adopted in a co-operative computer engineering course in order to maintain its quality and improve the students' learning process. The first practice is related to the introduction of the class council, a quality process which involves at least three meetings between professors and students (representing the class opinion) to plan the activities in the academic period, solve problems related to the course and jointly evaluate the results of this practice. The most relevant subjects are chosen to be discussed in an under-graduation annual workshop involving all professors and students to think about the future of the course. The second practice considers the usage of the continuous assessment process, focused on the student's learning. Some nontraditional assessment activities are shown as alternatives for traditional exams. Both experiences of the class council and the continuous assessment have produced good results in the computer engineering course through its application during the last seven years.**

Key Words- Class council, continuous assessment, co-operative course, under-graduation workshop.

INTRODUCTION

The Computer Engineering Course of the Polytechnic School of the University of São Paulo (EPUSP) was started in 1989 in the co-operative format, in which students alternate academic and curricular apprenticeship modules. There is a common basic cycle in the first two years for all coursers of the electrical area, offered in four semesters. From the beginning of the third year, the Computer Engineering Course is offered in four-month modules, in a co-operative form, alternating five academic and four apprenticeship modules along three years.

Several aspects must be considered in the quality evaluation process of an undergraduate engineering course, such as: curricular structure coherence, professors' qualification, laboratory resources, student background quality, acknowledgement of the course by society, etc. The continuous education quality improvement can be achieved through students' participation. This paper presents some experiences through the class council implementation in the Computer Engineering Course of EPUSP, in which the permanent communication channel among students, professors and the course coordination has contributed for the course quality improvement. Important discussions between classes and their professors have been carried out for searching solution to unexpected problems.

Another focus of this paper is concerned with the students' learning process, as well as with the pedagogic and academic preparation of professors. The traditional evaluation process exclusively through exams has shown to be inefficient in many situations. On the other hand, through the continuous evaluation process, there is a more harmonious relation among students, professors and the content of the course. This paper also presents the problems in the traditional assessment process, besides discussing the advantages of a continuous assessment process.

THE CO-OPERATIVE COMPUTER ENGINEERING COURSE OF EPUSP

The engineering courses in the cooperative format were firstly introduced in Brazil by the Polytechnic School of University of São Paulo. Initially, places were offered in the Computation Engineering, Chemical Engineering and Production Engineering courses. This kind of course has its basis on the alternation between academic activities, which take place at the University and apprenticeship activities, which take place in enterprises [1]. These full-time activities keep the student's focus all the time, so he/she has only academic activities or only apprenticeship activities at a certain moment.

Nowadays, the cooperative courses of the Polytechnic School of University of São Paulo are offered only for Computation Engineering and Chemical Engineering, while the other courses are offered in the traditional way. In this case, the students take the entire course in a two-semester format, taking the apprenticeship simultaneously with lessons. Starting from 1999, the Polytechnic School of University of São Paulo began a reformulation in all of its engineering courses, creating a new curricular structure, called EC-2. In this new structure, the first year is common to all students of the school and it is called Basic Cycle. At the end of the first year, the students enter one of the four so-called Great Areas of Engineering: Civil, Electrical, Mechanical or Chemical. In the Electrical Great Area, the student has five options in a two-semester format (Automation and Control, Computer, Energy and Automation, Electronic Systems and Telecommunications) and only one option in the four-month form (Cooperative Computer Engineering Course).

All the engineering courses of the Polytechnic School of University of São Paulo last five years. The first year is common to all the future engineers (Basic Cycle) and the second year is common in each Great Area. The difference between the two-semester form courses and the four-month courses is in the third, fourth and fifth years. In the four-month course, the students alternate between Academic and Apprenticeship Modules. Figure 1 presents the current structure of the Cooperative Computer Engineering Course, which is the main focus of this paper. In this figure, for each period (semester or four-month), the months of the year in which there are academic activities are highlighted, considering that the months of January, February (50%), July and December (50%) are traditionally months of scholar holydays. In figure 1 it can be seen that, starting from the third year, the students of the Cooperative Computer Engineering Course alternate, every four months, Academic Modules in the University and Apprenticeship Modules in the enterprises.

	Jan.– Feb.	**Feb.–Jun.**	**Jul.**	**Aug.–Dec.**	**Dec.**
1st year		1st Semester		2nd Semester	
2nd year		3rd Semester		4th Semester	

	Jan.–Apr.	**May.–Aug.**	**Sept.–Dec.**
3rd year	1st Academic Module	1st Apprenticeship Module	2nd Academic Module
4th year	2nd Apprenticeship Module	3rd Academic Module	3rd Apprenticeship Module
5th year	4th Academic Module	4th Apprenticeship Module	5th Academic Module

FIGURE 1
STRUCTURE OF THE COOPERATIVE COMPUTER ENGINEERING COURSE OF THE POLYTECHNIC SCHOOL OF THE UNIVERSITY OF SÃO PAULO

CLASS COUNCILS

Considering the context that each course should have its own internal assessment methods, always seeking its continuous improvement, in the Cooperative Computer Engineering Course, two initiatives can be mentioned that have been adopted in the last years: the class councils that take place in all Academic Modules and the Under-Graduation Workshops that are accomplished every year. These two initiatives have distinct purposes, but they are complementary if we consider the quality and improvement of the course. The methodology of the class councils is described below.

Starting from the year 2000, the need of changes in the coordination of the Cooperative Computer Engineering Course was realized. As students began to have a more critical attitude regarding their own life and about their future behavior in the job market, the need to get a closer communication channel between students and professors was naturally perceived. Yet the nature of the cooperative courses feeds this students behavior in the sense that they bring questions and feedback about the way the disciplines are taught and also about real situations. This entire environment propitiates a rich forum between students and professors, positively influencing the contents of each discipline in the Academic Module. In order to get a better benefit of the disciplines, the Class Councils [2] were established, and the main aims are:

- **Integrating professors**: this happens due to the periodical meetings involving all professors that teach a same Academic Module;
- **Stimulating the didactic planning of the disciplines:** each professor, individually, has the didactic planning of his/her discipline. This planning is dynamic and can vary at each offering of the discipline, even if its official content is not changed. The integration between the various contents of each discipline can occur when all professors have knowledge about the contents of the other disciplines. This can be done in the form of works and small designs that encompass more than one discipline at the same time;
- **Detecting incompatibilities between didactic planning**: occasionally, for lack of information, any content could be inadequately approached by the professors. This could happen due to the fact that each professor may think that some content would be taught by someone else, in different disciplines;
- **Synchronizing related disciplines**: mandatory disciplines that have complementary contents can depend, reciprocally, on themes taught in other disciplines. If there is not an adequate and integrated disciplines planning, a momentary lack of synchronism may happen between them, disturbing the learning process; and
- **Evaluating the amount of extra-lessons work**: it is possible, mainly in a new curricular structure that there is an accumulation of activities for the students in certain periods of the Academic Module. For example, a discipline could consume excessive time of the students in the accomplishment of extra-lessons activities, disturbing the normal activities of other disciplines. The collective meeting which aims to seek redistribution in the time needed for works, exams, exercises and extra-lessons activities can offer an integrated and more realistic planning of all disciplines.

The Class Councils began to be implemented in 2000 in the Cooperative Computer Engineering Course (classes with 40 students), from the 3rd to the 5th year of the course. Three meetings are accomplished in each Academic Module:

- Meeting for didactic planning of Academics Modules;
- Meeting to follow up Academics Modules; and
- Meeting at the end of Academics Modules.

All Class Councils meetings are chaired by the Course Coordinator or by a professor designated for this purpose. It is recommended that this person has a broad and thorough vision of the course.

I. Class Councils Composition and the Roles of their Participants

For each Class Council meeting, all professors that will teach that Academic Module are invited, as well as the representatives of the students. Such representatives are elected (two or three students) by all the class. Each member in the meeting has a role:

- The chairperson of each Class Council must care for the maximization of conceptual talks, always seeking the improvement of the teaching/learning process;
- The professors of all the disciplines must have the planning of each lesson, interact with the other professors and report experiences (positive and negative ones) from other offerings of their disciplines; and
- The representatives from the students must effectively represent the class, bringing opinions and informing the class about what is said in the meetings.

II. Initial Meeting for Didactic Planning of the Academic Module

In the initial meeting for didactic planning, foreseen to last about 90 minutes, the professors (normally seven in each Academic Module) present their planning for each lesson of the discipline, starting from the scholar calendar, previously published. In this planning, besides the contents to be taught in each lesson, the foreseen times related with extra-lessons activities and also with the evaluations are estimated. Standard planning forms for each discipline are given to the professors, allowing the standardization of all information. Such information is available to all professors of that Academic Module and also to all students' representatives.

Each professor briefly exposes his/her planning and, in the sequence, talks are promoted, seeking the integration among the disciplines, avoiding overlapping of their contents and also allowing inter-relationship between them by means of examples and multidisciplinary designs. The students' representative can aid in the refinement process of the activities temporal distribution, such as exams, works, designs and exercises. If anyone notices an accumulation of activities in some periods of the Academic Module, the professors can make adjustments as agreed with the other people in the meeting.

III. Follow-up Meeting of Academic Module

The follow-up meeting takes bout 60 minutes and is accomplished in the middle of the Academic Module, when some assessments have already been made. Occasionally, not all integrated planning made in the previous meeting could be accomplished according to the expectations, or there are results from experiences made in any discipline that can already be commented. This is the right moment for the class representatives and for the professors to talk about aspects related with the disciplines.

A purpose of this meeting is to identify possible problems and to propose solutions, considering the different opinions of all members in the meeting. It is an excellent opportunity for professors to revise problems associated with their disciplines. Occasional punctual students' problems are analyzed. This process has a pro-active feature, on the part of professors and students, and must be managed by the course coordination.

IV. Closing Meeting of Academic Module

The third and last meeting of the Class Council has an estimated duration of 90 minutes and aims to identify what the positive and negative aspects were along the Academic Module. This panorama considers the professors' and students' opinions. The ideal moment for conducting this meeting is soon after the final exams, but still before the remedial work period.

In this meeting, the exchange of experiences between professors and class representatives is stimulated as is the talk about the disciplines success and failures. Starting from the conclusions of this meeting, it is possible to make an outline aiming at the improvement of the next year course. It can be highlighted that the list of points to be analyzed comes both from the professors and from the class representatives.

V. Meeting Record

For each of the Class Councils meetings a record is made with the main topics examined, organized by each discipline or even classified as general purpose. These records have vital importance in the process, because they keep the history of the course and methods used and also allows following up problems and their solutions. Such records also allow the recapitulation of the main occurrences in the Academic Module.

VI. Reports from the students elaborated by their representatives

At the end of the Academic Module, the class representatives prepare, with the support of all other students, a report that relates the progress of the disciplines taught in the period. In some situations, the class representatives also elaborate a report for the follow-up meeting, previously described. In order to elaborate these reports, all students must participate, under the coordination of the class representatives, and answer a form that contains questions about the professors (didactics, dedication, responsibility, punctuality and teaching/learning techniques used), discipline (difficulty degree, connection with other disciplines and case studies) and didactic material (adaptation, availability and quality). In the form, there are objective questions that are answered with a grade between 0 and 10 and places where the students can describe their opinions about the disciplines and the professors by means of a text. These two forms of opinion are very important. One important thing to consider is that the questions in such forms are all elaborated by the class representatives.

Thus, this report contains a compilation of the answers of the objective questions as well as the main qualitative opinions that are not covered by those questions. So, this report constitutes a very rich document about the class satisfaction, the professors, the disciplines and the didactic material.

The ideal condition is that this report can be finished before the closing meeting of the Academic Module, allowing its analysis. It is important to say that the integral

responsibility for this report is the students' and their class representatives'.

VII. Reports from the Professors About their Disciplines

More recently, the professors also requested the opportunity to elaborate a report, under their point of view, about the elapsing of the disciplines, also documenting positive and negative experiences. This instrument also has an important role in the closing meeting of the Academic Module, because this report and the one from the students can be joined, allowing a very complete view about the Academic Module.

VIII. Meetings with the Group of Students

Besides all this process, there are important meetings accomplished with all the students. The first is the reception of the new students to the Cooperative Computer Engineering Course when they choose this option at the end of the 2nd year. For this event, all professors and students involved in the entire course are invited. It is a great opportunity to explain the structure, the main goals of the course and the profile of the future new engineers to be formed in this course. It is also a celebration event in which the participation of class representatives of other years and, eventually, ex-students of the course is common.

Another celebration occurs at the final presentation of the Course Final Work that takes place on the last day of the 5th year of the course. Again, this is a celebration event gathering professors and students.

Recently, it was noticed that in spite of all this quality process, it is possible that one class loses its motivation in any Academic Module, for several reasons. Occasionally, a class can be anxious about having more vocational disciplines, earlier in the course, thinking that the entire course has only basic and conceptual disciplines. One solution for this problem is a talk by the coordination of the course and also the professors, with the entire class, explaining the complete course structure, trying to revert this situation.

IX. The Under-Graduate Workshops

The Under-Graduate Workshops were created in 2001, in the Computer and Digital Systems Department (PCS) from Polytechnic School of the University of São Paulo. PCS is the department responsible for the Cooperative Computer Engineering Course. These workshops are accomplished annually, after the end of the scholar year (mid December). The main goal of the Under-Graduate Workshop is to congregate all professors of the Department around the under-graduation theme, considering that this theme is a priority in the Polytechnic School of the University of São Paulo.

The workshops are accomplished along an entire day, outside the university, allowing a complete involvement of all participants. All the PCS professors, some professors of other departments with some disciplines in the Cooperative Computer Engineering Course and class representatives of all classes are invited to the workshop. The total number of participants is around 40 or 50 people, 25% of them are students.

The dynamics of the workshop can be summed in the following steps:

- Definition of the workshop theme;
- Division of the participants in homogeneous groups (considering their knowledge area) for the accomplishment of previous work for the workshop;
- Definition of the speakers for each workshop phase, generating motivation themes;
- Talking within each homogeneous group, allowing the emergence of more specific results;
- Results presentation of each homogeneous group;
- New talking about the results, now in heterogeneous groups (representatives of several knowledge areas), seeking the building of a more comprehensive view;
- Results presentation of each heterogeneous group
- Final talking among all participants;
- Workshop record elaboration; and
- Designation of work groups to analyze the workshop results and to propose an action plan.

CONTINUOUS ASSESSMENT METHODS IN THE LEARNING PROCESS

One of the main points at the beginning of the discipline, in which continuous assessment/learning is intended, is to clarify to the students how the discipline will be learned and how the assessments will be made.

It is extremely relevant to be honest with students. Every learning way that will be used, assessment methods and programmatic content, must be highlighted. It must be emphasized that the search for knowledge foundations should be based on a need, which is the main aspect in any development process. Therefore, need must be disseminated among the students through the resolution of practical problems and challenges pointed out in class. The presentation of the discipline in this way causes an intrigued reaction by the students, besides being positive.

After the initial presentation of the discipline, the learning process and continuous assessment, it is extremely relevant to listen to the students' opinion concerning this new process. This position reflects a commitment to be made by the students, since they are now deeply involved with well understanding the course, to make an effort to obtain real participation along the course. By the dialog among professors and students, it must be clear that the responsibility for the quality of the discipline is a task of both parties. If the discipline is a success, the merit will be everybody's; if the discipline be a failure, the responsibility will be shared by both parties.

An option to mark this responsibility can be done through the use of a declaration of commitment elaborated and signed by each student [3]. After this initial dialog, the professor can ask each student to complete the next statement: "I, <name> acquired a good learning in this discipline because of the following reasons:…". At first glance, anyone can think this infantile, but it has an enormous effect on changing the attitude of the university student, totally vitiated in bad and unmotivated education along the first eleven years of their lives. Through the evaluation of one of theses answers, it can be verified that

students are invited to reflect about this new process, making them abandon a simple passive posture, to assume an active critical action along the course. They feel challenged and motivated for new conquests.

After this initial preparation, the discipline begins. At this point, the professor must take care not to frustrate the expectation created through this initial dialog. In this way, the professor must select problems and challenges to the students aiming to make them search for the necessary knowledge for the resolution of these aspects.

The different continuous assessment methods can be divided, for example, in function of the agent that makes the assessment: the professor, the self-student or other students [4].

By the experience acquired along some undergraduate disciplines, it was verified that the inexistence of pre-defined days to make assessments is an excellent option. One first good result is the elimination of the "Test Day", extremely unpleasant and inefficient in the learning point of view. Evidently, there is an initial reaction by the students, but they quickly adapt to this new process, specially if the objectives until then have been clearly explained.

Among all the different continuous assessment techniques, the following can be pointed out: problems to be resolved in class, problems to be resolved out of class, research works to be done out of class, participation in the class discussions and continuous assessment made by the student and made by colleagues.

I. Problems to be Resolved in Class

The problems to be resolved in class can be applied after a brief explanation of the respective theory or after the experimentation with other problems in class dealing with the same theoretical concepts [5]. It is extremely relevant to adequately choose these problems, since based on them the motivation of the students will be aroused to search for the necessary knowledge. At this moment, it is important for the professor to be aware if the students are really acquiring the necessary knowledge through the adequate text supplied for reading. In some cases, the professor shall complement the theory by the use of an expositive method. The professor must have the capacity to feel this need and choose the right moment in the class. After the individual resolution of the exposed problem, the professor receives all the solutions and incentives the debate with all students about which would be the correct solution or the most adequate solution for the respective problem. This feedback is essential for the student to know exactly where and why he made any errors.

II. Problems to be Resolved out of Class

Some problems can be resolved out of class. This kind of activity must preferably be conducted in groups, thus decreasing the idea of copying solution and enforcing the concept of the need to debate, in group, the possible solutions for the exposed problem. Again, this kind of work makes the importance of the student participation in the learning process stronger. In this kind of work, the assessment can be made in class through group presentation, showing the solution adopted by the group, or receiving the different solutions. At this point, it is extremely relevant to have the feedback from the class in function of all the solutions presented for their respective problems.

In the group work, the professor can attribute a value to the presentation and the students have the responsibility of distributing this assessment among the other colleagues of the group, maintaining the final value applied by the professor. Based on our experience, this kind of group assessment is more efficient when students rely more on the work of the professor. Thus, this evaluation can be applied in the second half of the discipline, when the class has already understood the new learning process and its responsibility in this new context.

III. Research Works to be Done out of Class

Another assessment method implemented by the professor is very interesting and is related to research works done in groups out of class. The adequate choice of work to be made is a relevant point of this kind of activity. This work shall be challenging, motivating and adherent to the pragmatic content of the discipline. The goal of this activity is to show the application of the concepts in complex real systems. The research work must be developed in groups and exposed in class. The professor must be aware not only of the concepts acquired and presented by the group but also of the way the presentation is implemented and how it is described in a technical report.

The study of technical papers in refereed journals constitutes a kind of productive group research work. The papers must be chosen by the professor aiming to obtain a perfect harmonization with the programmatic content of the discipline. A good chosen paper enables students to assess their learning in that topic, besides causing satisfaction in understanding advanced research texts about the topics discussed in class.

Evidently, it can be necessary for the professor to complement the concepts presented by the students, elucidating some doubts originated during this kind of work. Presentations cannot become boring and long. A possible solution is to distribute the presentations along many lectures, using the papers as a way to illustrate the different concepts studied in the discipline.

IV. Participation in the Class Discussion

One of the main points in continuous assessment is the effective participation of the students along the different lectures. This kind of assessment is extremely difficult, especially for students in the last year of the course, since they are very worried about their future careers. However, this difficulty can be put clearly and faced with the students. Through continuous assessment, students must be present to most of the lectures and not on some "test days", since they do not exist.

It must be highlighted that, through a good initial clarifying work, occasional resistance against frequency control can decrease significantly. As the course proceeds, students better understand the importance of their participation and the new responsibility during the course. The professor can and must attribute a value to each student, in function of his/her effective participation in the debate

along the discipline. It is not enough for the student to be present; he/she must actively participate.

V. Continuous Assessment Made by the Student

This kind of assessment is the most complex and depends fundamentally on the awareness each student acquires along the course. Thus, this kind of work must always be done with another kind of assessment, also trying to eliminate probable unfairness. In this evaluation process, the existence of self-demanding students and others not so can be clearly observed.

At this moment, the way this method is conducted can help in its efficiency. An important aspect is to try to awake the student's sense of responsibility and criticism towards learning. To increase this responsibility, the student can also be prepared to conduct an assessment of the discipline and of the professor [6]. The professor must be aware about the most adequate moment to apply this kind of assessment. This perception must be linked to his/her sensitivity with the responsibility for the class beyond the course.

Furthermore, the application of this kind of assessment at the beginning of the course can be inefficient, make the student adopt an irresponsible attitude during the discipline. The best moment is when the student is well aware of this responsibility, learning and relies on the professor. Actually, any learning work is based on a trust relationship between professors and students.

VI. Continuous Assessment Made by Colleagues

This kind of assessment is extremely interesting. It is relevant to share the evaluation responsibility of one student among other colleagues. This kind of assessment makes the students assume responsible positions related to other colleagues, not to judge them, benefit them or hurt them, but fundamentally to adopt responsible attitudes over the each one's learning. Through this assessment, students are compelled to take a critical position not only about their colleagues, but also about themselves. In this sense, this process will also have great influence on future self-assessments.

Many times, different students have pointed out the difficulty they feel when assessing their colleagues. When this aspect is deeply studied, the main cause of this difficulty lies on the attitude of not having the responsibility for this kind of assessment. However, this is a natural attitude and frequent along our professional life. If the student also takes this responsibility, it can help him/her to obtain a better maturity that will reflect in his/her professional life.

This kind of evaluation can be applied to other works implemented out of class. In all presentations in class, the students can receive a form, with which they can assess a specific work-group. Again, the kind of questions in this form can help in a good conduction of this kind of assessment.

CONCLUSION

All the improvement quality process of the undergraduate course adopted in the Cooperative Computer Engineering Course of EPUSP has the important participation of students' representation. For the students' participation to be effective, it must be pro-active and they must be stimulated to be aware of the course quality. Many problems related to the teaching method could be improved through the meetings established for each academic module. Furthermore, integrative projects could emerge from the important discussions among professors about all the activities planned for a specific academic module.

On the other hand, the practice of the continuous assessment system in some disciplines presents some advantages. Considering the traditional evaluation that was widely used, this new evaluation process caused a greater interest in the course and a better learning by the students and more engagement of the professors with this process. Professors must be aware of applying adequate techniques of assessment at an appropriate moment of the course.

Finally, the integration of the application of new techniques of evaluation and the class council process produced satisfactory results in the conduction of the Cooperative Computer Engineering Course of EPUSP.

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