

An Experience In Educating Engineering Educators

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Abstract

The importance of a solid training in education for professional engineering teachers has been increasing very rapidly in Mexico during the present decade, due in part to the rapid technological changes imposed by our epoch, in part to the globalization of education and the professional activities, and in part to economic treaties (like NAFTA) with other countries of the Americas, Europe and the Pacific. One key and nearly virginal area of knowledge for engineering educators in Mexico has been “education” itself. While keeping pace in responding to the technical interests normally found in courses taught at the continuing education level, the Faculty of Engineering of Autonomous University of San Luis Potosi set forth to face the needs of its own staff, through a program created by its Department of Continuing Education, for a better and more satisfying profession in education, which has led to many gratifying results.

I. Introduction

Universidad Autonoma de San Luis Potosi is a typical public Mexican university, possibly representing Latin American public universities in general. Though even if it includes in its title the statement of “autonomous”, it strongly depends for its operation from federal funds which, sometimes, are determined by political and national goals.

The main campus of the university lies in San Luis Potosi, capital city of a state by the same name. The city, located nearly midway between Mexico City and Monterrey, the second largest industrial city in the country, has about one million inhabitants with 10 universities and colleges and three large technical schools. Its main educational institution - in terms of enrollment, budget and tradition - is our Universidad Autonoma de San Luis Potosi, with a history dating back more than a century and enjoying an important national academic recognition.

This university comprises in this main campus - out of its total of four - 14 faculties (offering 46 different careers), ranging from medicine and engineering, through psychology and communication sciences. Plus 6 research institutes, ranging from the internationally accredited Optical Communications Institute and the Physics Institute, to the Research Institute on Humanities.

The institution has a student population of more than 26,000 at the bachelor’s level and over 500 at a postgraduate level. It has a payroll of more than 2,500 professors and researchers and 2,000 clerical employees.

The School of Engineering offers 12 different careers, spanning from Mechanical and Civil engineering, through Computer Sciences and Surveying. The enrollment is of over 2,500 and the

staff comprises more than 300 teaching and research personnel, including more than 80 full-time professors.

The Faculty has 8 programs at postgraduate levels (including three Master's degrees and one Ph. D. in Electrical Engineering). The School also offers a great variety of short courses and diplomas. (These Diplomas must be supervised by the central Academic Department of the university which, among other things, requires a minimum of 160 hours of instruction.)

In the 1950's, San Luis Potosi had an incipient industry; which, however, began to demand a greater number of engineers, normally arriving from larger cities in the country. Engineers in the field began to teach in the newly opened School of Engineering, as a social service. But soon, outstanding students were invited to teach as auxiliaries, sometimes even before graduation and with no prior training in teaching. This situation led to a staff highly improvised; motivated perhaps, but with an enormous lack of teaching and learning principles, even though through its Institute of Educational Sciences, the university has offered to its professors different courses on pedagogy and educational techniques.

To help professionals of engineering, and from related disciplines, in their ample and constant search for improvement, the Faculty of Engineering created its Department of Continuing Education in 1985. Soon, alumni of this Faculty began to propose courses related to management and finances, besides up-dating technical courses normally found in engineering continuing education. The catalog, during these years, has amounted to over 200 different courses.

Due to its own market research, the Department itself has created courses which range from communications, to applied computer software; from reengineering to the Japanese language; from ethics to computer-aided education; from GPS to energy savings. And soon it became evident that professors, participating as "students", had many deficiencies in their professionals training, such as:

1. a lack of appropriate oral and writing skills;
2. a very poor orthography, unacceptable in professionals;
3. a very poor vocabulary, specially in the humanities area; and
4. a very poor and insufficient preparation, for historical, philosophical and social discussions.

This lack of a broader and necessary culture in educators, has had a definite negative influence in:

1. the integrated education of the students (in spite of the courses on "humanities" embedded in the curricula of engineering); and
2. the academic production of the educators themselves.

Even researchers graduated abroad, have shown this same lack of a broader culture.

Due to internal (the university's) and external (the North American Free-Trade Agreement, globalization, etc.) pressures, the university is taking some actions to improve its educational status:

- An increasing requirement for higher academic levels of its professors (Master's and Ph. Ds).
- A national certification for its alumni.
- An accreditation for the institution, staff and curricula.

This last action with the intention of complying with the international standards set forth by the participating NAFTA countries and as a preparation to participate in broader international projects¹. It has already led to international "... mutual recognition of credits, programs and grades in higher education"², and to official proposals such as "... support for the profesionalization and protagonism of educators"³.

On its own accord, the Department of Continuing Education decided to implement a program for teachers of the Faculty of Engineering, to better understand their profession as educators; "professionalizing" this way, their activities. The intention was not to reproduce the courses taught at the Institute of Educational Sciences - giving participating professors the universal teaching tools traditionally demanded - but rather to give them the adequate background on education (the different historical approaches on education, present theories on knowledge and intelligence, etc.) so that they might create their own personal teaching tools designed for their special personal situations.

The four-semester program born with this intention, soon evolved to become a Diploma and soon again became appealing to professionals of other disciplines and teachers of other schools in the university. And it is this project, the experience we now wish to share.

II. Background

The massification of education in our country has obliged educational institutions, in general, to improvise their staff. Our school of engineering is not the exception, and since its enrollment has been increasing for quite a number of years, the authorities have seen the need for improvising its staff created out of its own alumni body, whose formal preparation had been focused towards very specific aspects of the curricula and little, if any, related to teaching and education.

This improvisation has been extended to all other levels of education also, from elementary schools to universities, whose consequences are reflected in the preparation levels with which Mexican professionals emerge. This situation is also related to other aspects of the political system itself, where due to a lack of sufficient funding, little is research promoted in the educational arena.

In the search for improvement as mentioned above, a higher level of formal education has been demanded from teachers; i. e. that they must have a specialization, a Master's, or even a Ph. D. degree, trying to motivate them by means of economic incentives. Unfortunately, many of these persons are looking for this degree only because of its monetary return, and no positive repercussions on education have been shown as inherent to the process. Besides we are aware of what Phillip C. Wankat mentions about Amundson statement "The subject of teacher education is held in such low regard by the academic community (except in professional colleges of education) that almost no effort is made to emphasize at the university level the training of future pedagogues"⁴.

Joining all this, managerial criteria are applied to the teaching activities, where the students are considered as “*the raw material*” to be transformed, and the teachers as “*the workers*” of education. This “blue-collar” view has transformed the creative teaching activities into mechanized and repetitive actions with immeasurable consequences.

Since its creation, as implied before, one main preoccupation of the Continuing Education Department of this Faculty of Engineering, has been the search for alternatives to the solution of detected real problems in engineering professionals. And, obviously, its first goal would be to help the professors of the Faculty itself to get a better preparation for their teaching activities by giving them a different and better sense to their occupation, and a new way of understanding it: that it is not the same thing to mold an inert raw material, as submitting a live, thinking human being, to a transforming process.

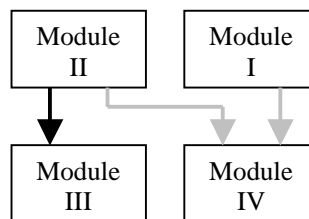
From these ideas, by 1991 the Department took a first step to “professionalize” these teaching activities, and the content of a course began to take shape expecting that the participating teachers, now as students, would open their minds beyond the subject they taught, so that they began to look for analogies among different areas of knowledge; to appreciate likenesses in the application of concepts, as well as their differences; etc. The candidates should be, as a prerequisite, involved in teaching or in related educational activities.

Nevertheless, to make the content get a sense, it was important to establish a methodology that could maintain the attention of the teachers, making their participation attractive. Little by little active methods came to life, implementing them in the four modules that comprise the program.

III. The Program

The program, later tagged as Diploma on Education, comprises four modules of 40 hours each distributed in 14 weekly sessions, with a sequence depicted in Figure 1 by means of arrows. The gray ones in the drawing mean that a candidate may be accepted for Module IV, even if either Module I or III is being taken at the same time. The dark arrow implies that Module II is a prerequisite for Module III.

Fig. 1 Sequencing of Modules



Each module is offered along the regular semesters of the Faculty, with enough time for the participants to prepare the final paper or report. Due to the need of making the interaction among the them more effective, their number has been restricted to a maximum twenty in each generation, though occasionally the enrollment has been allowed to twentyfive under special circumstances.

Each module has one specific content and special goals, which jointly contribute “to improve the teaching practice of the participants through a training that may allow them to integrate the different areas of knowledge to achieve the institutional goal of ‘Excellence’”.

III. 1 Module I

Content: A brief tour on the origin, evolution and present state of higher education institutions in Mexico, and their relationship with the social environment where they are established.

A brief historical tour of the educational systems and concepts is performed while establishing the relationship that has existed between the sociopolitical and economic systems and education. Several stages, which permit to perceive the importance of this relationship, are considered, as well as the roles teachers have performed historically along with their social consequences.

This brief analysis allows the participating teachers, as they situate themselves in the present, to realize how their role has evolved with time, the complexity it encompasses, the reasons for its failures, and to perceive the possible consequences if they follow the same path with the same conventional teaching methods in the face of a changing world.

III.2 Module II

Content: The theory of knowledge; analysis of the different schools of thought, from Socrates to our days, and their application to teaching.

Once again a historical tour is performed, but now it is done while reviewing the way knowledge has been studied as well as its relationship with education. This relationship allows a reflection on the reaches of knowledge which are not restricted to the sole transmission of information, but rather may lead to the most limiting and narrowing sense reached through specialization. Each theory is analyzed in the light of present facts and their applications.

The review of different positions in specific times and places allows many professors to get to know the diverse ways youngsters acquire knowledge, the most effective means to transmit it, and the whole new fan of alternatives available. A reflection is made on little known aspects, such as the stages of intellectual and cultural development, the difficulty and derived consequences of specialization, and the valuation or devaluation resulting from all of this.

This panoramic view is useful to reflect on the need and importance to retake the idea of multidisciplinary in teaching, as well as the integration of ethical concepts and values which correspond to the development of the socio-moral judgment seeded by Piaget⁵.

III.3 Module III

Content: The different tendencies applied to intellectual development are analyzed; and some exercises are made with them. Their importance and their repercussion on practical life are questioned, from which questions as: “*What happens with responsibility, honesty, ... , etc.?*” arise.

The discussion, analyses and reflection on the different types of exercises give the participants an awareness of their individual differences, of their own personal capacity and that of others for intellectual and moral development; and of the need to open the doors of teaching to more versatile and flexible models.

It is obvious that those who have the answers to the problems are likely to succeed in life, but under what conditions? Some of the problems our country is facing are due to corruption, which lead to questions such as: “*Can any solution be given at no matter what price?*”

Even if the module is focused on intellectual development, questioning and reflecting on the importance and the relationship between intellectual development and social judgment is made. Piaget⁵, considers that so much one as the other must be taught at the same time. Even so, Kohlberg⁶, on the other hand, considers that in our societies there is a displacement between intellectual and moral developments, meaning that in education this is fundamental, even in higher education.

III.4 Module IV

In this module, the problem the participating teachers want to tackle, under their own initiative and personal situation, is born or initiated, based on ethnographic methods emerged from direct observation.

The investigation becomes a personal challenge for each participant, since the problematic involved is different for each one. This new role makes them perceive the problem in its whole magnitude, detecting their resources, defining alternatives and taking their own decisions, for nobody else is living the same situation.

Personal advice becomes extremely important so that participants do not abandon their projects at the first stumbling they encounter, especially when they modify their methodology and expect immediate results.

At the same time the participants are performing their research, they share their experiences with others, which helps them generate new ideas, or see the problems from a different perspective, visualizing, through them, unexpected alternatives.

The investigation is done through four stages:

- detection of the problem;
- selection of the methodological strategy;
- data gathering and recording;
- analysis and interpretation of results.

At the end, to credit the program a report must be made with the whole integration of the research. The “graduates” have extra time and advise to complete the report under a formal and printable presentation. The summary of these reports from the first generation, was printed as a memoire⁷.

III.5 Evaluation

Each module has its own criteria for crediting the participation, but in a general way they comprise:

- A minimum assistance of 80% of the sessions.
- A minimum grade of 7.0 within the official scale of the university of 0.0 (minimum value) through 10.0 points (maximum value) in each module. However, to credit the Diploma the average mark of the four modules should be at least 8.0.

These conditions comply with the University regulations for these kind of studies, the Diplomas.

The grading includes:

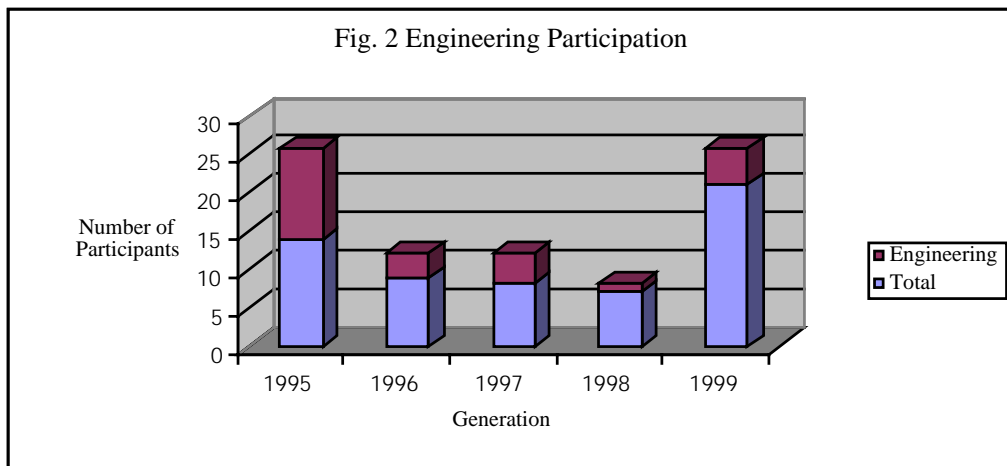
- Participation in the classroom.
- Answering a questionnaire before each session.
- Writing a summary of certain topics.
- Writing up a final report.

IV. Results

IV.1 Short-term Results

Initially the general tendency of the participants is to assume the same behavior, habits and attitudes they criticize in their students, such as: arriving late to the sessions, late deliverance of the questionnaires, taking notes they will never see again, a non communicative attitude, demanding bibliographic references they will never consult, etc.

Even if the program was originally designed for the Faculty of Engineering, its existence was well known after the first module, but, unfortunately, engineering educators became a minority. Figs. 2 shows the percentage of graduated participants in the 5 complete generations to date.



Each session is initiated with those present (lack of punctuality seems to be a chronic disease in Mexico). The participants work on the material they must bring already filled-in and they all must participate either voluntarily requesting the floor or obligatorily when their opinion is demanded.

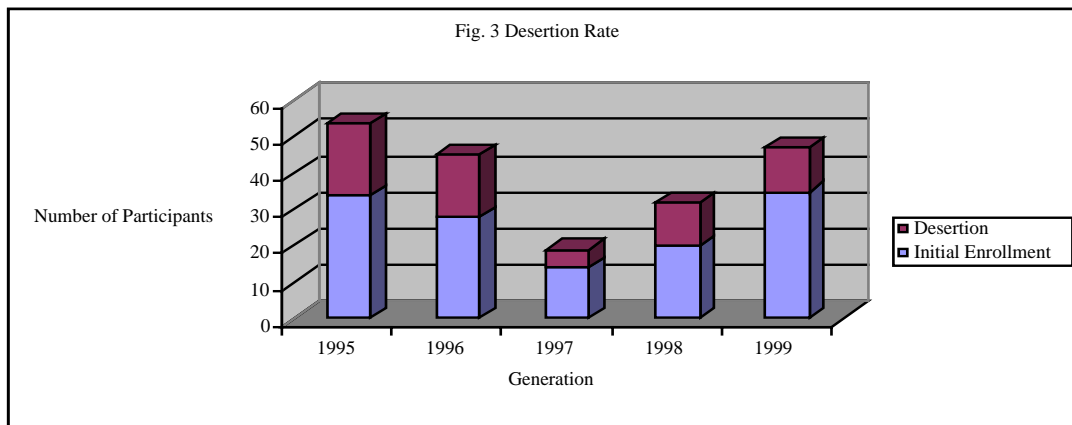
After three or four sessions, most of the participants start arriving on time to undertake three hours of intense activity, along with their questionnaires already answered.

The same thing happens with their writings, where seldom are they required to write them again; their mistakes or failures are outlined when reviewed by the instructors and they are asked to take these corrections into account when preparing the next papers. This gives them the confidence and certainty to solve their problems.

Two main factors related to teaching have been found in the participants:

- Their difficulty to write a text product of a personal reflection. This is given in modules I and II; and can be said to be the most frequent variable related to this course (about 90%).
- Lecturing before a group, or having some problem of personal origin to face audiences. Although these are rather isolated cases.

Desertion in module I is roughly 45%, in module II about 15%, and negligible (almost non-existent) in modules III and IV. Fig. 3 shows the total desertion rate along the five generations already graduated.



Those who have finished the program have achieved the following:

- A considerable improvement on their writing of papers, where participants can realize their own advance. The Department keeps a copy of each work.
- A development on their self-confidence to generate work alternatives, beginning with presentations of papers about their own achievements in local forums.
- Without changing the imposed topical contents, they have developed strategies that have allowed them to improve the approval and desertion rates in their students (reducing those of flunking).

- All of the participating professors have designed special exercises that have helped their students to increase the understanding of topics. But some have designed teaching material as well (such as a Work Contract, interactive games to teach physics, etc.).

V. Consequences

The observed results derived from these modules are easily perceived in some of the participants from the very first sessions, especially with those who are more perceptive and willing for a change, if they see the possibilities for an improvement, besides being aware of their lack of preparation in this area of knowledge.

V.1 Findings

Through the five generations graduated, some common features have been found in most of the participating engineering professors, not easily brought to their conscience, such as:

- They hardly know history, whether local, national or worldwide.
- Their cultural level is limited to the knowledge proper of their area of specialization. As Wankat⁴ remarks "... Engineering and Science professors have discovered that Education professors (and those in anthropology, counseling, psychology, and sociology) have skills we don't have and that we often need to receive education grants."
- They constantly complain about the irresponsibility and disinterest of the students.
- Their teaching system is characterized as lecturing and authoritarian, giving little opportunity for the participation of the students.
- They have little or null preparation for the teaching profession.
- They are highly resistant to accept the benefits of a personal change, since they consider that all failures emerge from the students.
- Little reflection is given to their own behavior in these courses, which becomes a reproduction of that presented by their own students.
- They have a lack of verbal skills, specially in the writing and interpretation of texts.

After some sessions changes of attitude began to be noticed, such as:

- Attendance and punctuality were considerably improved, especially, again, on those who since the beginning of the program arrive with the intention of doing their best. There are cases of professors who have no single delay to the sessions or ever missed one of them.
- Their writings go on improving, first in their edition and presentation (form), and then in their depth and reflection (content).
- Participation becomes denser and more voluntary every time, even when sometimes their points of view do not coincide, more notably in personal questions as whether the familiarization with the students is positive or not.
- This change of attitude bounces back also in the creation of an agreeable or disagreeable group environment. Although fortunately until now it has been possible to develop a cozy and warm environment, that does not mean that in some cases a tense situation may not occur; however, these cases have been reviewed and reflected on as an opportunity to perceive in an open way what in a camouflaged way happens inside regular classrooms.

The importance this favorable environment has acquired to discuss and analyze situations, even in contradictory positions, has been very attractive to some professors who had never had an opportunity like this, which also permits groups to be identified and to interact on educational topics.

The challenges that are generated eventually move the teachers to start looking for group activities, like visiting an interactive museum in another town, discussing their personal work problems and national social and/or political issues, organizing a social meeting, sharing experiences, etc.

The way they feel their lives have changed has made that most of those who presently attend the program have learned about it through recommendation of someone who had already taken it; this minimizes desertion and helps make a much faster personal advance.

V.2. Tracking

Due to the friendly and warm environment generated in the courses, those who have graduated keep a close communication with the personnel of the Continuing Education Department, and even demand from them advise to implement actions in their own classes, after they finish the program. This has allowed that some achievements obtained through “innovations” in methodology to be known by others through the follow-up forums the Department created with this purpose.

Among the long-term results one can point out are:

- ◆ Two professors of the Faculty of engineering, who finished the program, have been considered the best teachers in their academic area on two consecutive years, and they trace their success to their participation in the Diploma.
- ◆ One professor (an engineer) at a middle-education institution, changed her teaching strategies in the physics area and her students won the second place in a national contest the following year (1997), and the first place the next year (1998). She herself received a special recognition because of this. Her feats became a topic for a paper in one of the forums.
- ◆ One professor of physical education at the Faculty of Engineering, for many occasions a participating advisor and trainer in the Olympic Games, redesigned all of his teaching programs, based on the studies of the Diploma. His achievements were presented in one of the follow-up forums too.
- ◆ Another professor of engineering modified her material with which she improved their students’ markings and reduced their flunking rates.
- ◆ In the health area, three dentists have prepared teaching material which has permitted them to establish relationships with other areas of their profession, giving, as a result, a better participation of the students which eventually has led to a lower failing rate and to better results.

V.3 The Forums

Three forums for graduates have taken place, with 6 papers each, restricted only because of the time allowed. Nevertheless, the number of papers submitted was much larger, for which only those whose content was better related to the theme of the forum were chosen.

According to the expositions made in the forums:

- The program has changed the point of viewing the teaching activity as something routinary to seeing it as something creative, where each group is different, offering this way a challenge to the teachers.
- Module II gives the participants a different view of the "limited" and normally shared meaning about knowledge as synonymous of information, to understand it now in its much ampler concept. This also implies the reevaluation of its role, since its repercussions are more clearly perceived here by the participants.
- Performing a research project opens a new door to the multiple possibilities for action, starting from the observation and detection of "special" situations in the classroom.
- Another important factor has been the change of methodology. This became the topic for a paper in one of the forums (without considering those from other disciplines) by three engineers who teach mathematics, physics and hydraulics. In these cases, the change of methodology was ignited by the awareness of their reality, through interaction with the students. The teachers developed strategies that took them to considerable achievements:
 1. Reduction of the desertion rate by nearly 100%.
 2. Increasing the participation of students in class.
 3. Increasing the students' grades, based on traditional examinations.
 4. Personal satisfaction of the teachers when realizing their success.
- 3. Something extremely important and decisive for others to continue their permanence in the program, was the environment where they could argue and differ, without losing respect. In some occasions even when no agreement was reached, when leaving the room the differences in opinion were left there in it waiting for some other more promising occasion. Other participants even considered that attending the sessions was very relaxing.
- 4. Another thing that was not contemplated initially but exposed by several professors inside and outside the forums, was the improvement of family relationships.
- 5. When the professors began to give a different sense to their work, they also changed their lives; they began to see their jobs as motivatin; they began to see everything different, leading them to changes not only in their attitudes and behavior, but also in their character. It can be mentioned that some of them even changed from a little communicating and serious face to a smiling one, ready to talk.

Many of the graduates continue preparing material to make their courses interactive.

Two of the professors, one in engineering and another one in physics, openly manifested at the beginning of the program, their skepticism for a possible personal change; but then, when they finished it, they publicly recognized the successes they had obtained when they changed their methodology. This second professor even designed a course to teach professors of physics to use an active procedure.

VI. Conclusions

The controlled and detailed care on the activities of the staff, the personal advises demanded from them, the suggestions by the participants themselves, the sharing of their experiences, etc., have been influential factors for the success of the program. But, at the same time, participants show an ever-present need to participate in a better shaping of those who, like them, are going to make their living within the educational environment, whether teaching or managing higher education institutions.

When summing up the experiences detected, the Department has arrived at the conclusion that even if the contents are important, methodology is even more so for it unleashes the breaking of habits perfectly established and difficult to forget; such as the following (which are by no means exhaustive):

- To transcribe, so as not to think;
- to demand bibliographic references, as a “security blanket”, with no real interest to consult them;
- doing things in a mechanical way, like lecturing and preparing exams (transcribed and/or copied from books);
- to reconsider the slogan that “the teacher is the authority”.

When breaking these schemes, discomfort is generated, for not always do people have the weapons (knowledge) to face the change, nor the confidence in themselves (a reason some people desert the program).

These aspects have been present all the time. With this in mind that the program tries to break the habits simultaneously to pursuing its own goals, and the participants are given the necessary elements to be aware of the potential they have which they can tap to be used for their own benefit and for that of others.

The tasks assigned to participants are the means to show them their productive potential, stopping their being mere reproducers of things - of things perhaps they may not even understand.

The successes achieved by participants have shown that something fundamental is the recognition of the ample meaning knowledge has, and which cannot be “restricted” to a certain specific area. This conception has permitted the goals stated in the program to be reached, and even superseded.

These achievements are documented in different forms:

- Through their research papers.
- Their exposition of results in ad-hoc forums.
- During special presentations in the modules.
- Through documents crediting their participation in contests and the prizes obtained.

Based in all this we have found that the following objectives have been reached:

- Recognition of differences in individual and group behavioral patterns, where the methodology applied to one group does not necessarily mean it is good for another.
- Flexibility to find different solving alternatives to reach the same result.
- Multidisciplinarity as a very important factor for teachers to understand that the same thinking processes may be applied to different areas, helping this way students to transfer and generalize knowledge.
- Flexibility towards discrepancies, allowing the students to found their own personal postures.
- The need of a formative evaluation to help the development of creativity, so much of the teacher as of the students themselves.

The achievements reached have had some consequences in the teachers when reconsidering their teaching profession:

- To perceive their activities as a challenge, more than a mere routine.
- To reevaluate their teaching jobs and their individual and social repercussions.
- To give importance to their attitudes and the way they consider their students (as thinking and acting beings and not as passive objects).

Addendum

This program has led to the signature of a long-term covenant between our institution and a major mid-level educational system in the state of San Luis Potosi, for a staff of nearly 500 professors (February 1999).

And presently, due to the motivation physicians participating in our Diploma have acquired from it, the Faculty of Medicine of Universidad Autonoma de San Luis Potosi has initiated, based in our program, the design of a Master's Degree in Education in the Health Sciences to be taught under the advise of our personnel. It will be very similar to the present program in its goals and methodology, but it will include topics like Ethics, Bioethics and Anthropology.

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