

PRECOCE: A PROPOSAL FROM UNIVERSITY OF BRASILIA TO REDUCE THE DROPOUT RATES IN THE ENGINEERING COURSES

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Abstract. *The Project of Continued Education in Engineering Basic Sciences, PRECOCE, is a project from University of Brasilia, UnB, as part of the actions of a program established by a partnership among government and industrial sector, called INOVA ENGENHARIA, which intends to supply a bigger number of high standard engineers which are needed to support the country modernization and development. PRECOCE is being carried out at UnB since 2007, and intends to attract students to engineer careers, awakening vocations and providing public school students the chance of building a background learning which may enable them to join the public university. In its methodology the project includes actions that aim to disseminate the work of engineers, projects and challenges defeated by these professionals, showing to students of public high schools that by a combined use of the "most feared sciences" in which engineering is based (mathematics, physics, chemistry, biology and computer science), it is possible to overcome the challenges Brazil needs to face to achieve a sustainable growth. There are initiatives for improving the teaching-learning materials and methodology in these areas, in order to provide a consistent, fun and enjoyable learning process. There is also a training program, which allows the inclusion of secondary students in the university environment, through the development of activities in multidisciplinary projects groups and laboratories of engineering courses. Students who show interest in following their careers in engineering may also participate in projects in robotics, structures, and renewable energy theme, these are the so called "special projects" that uses materials as playful as LEGO kits. PRECOCE adopts a structure of tutorial learning, where students from several different areas from UnB, work in an heterogeneous team (different semesters, backgrounds, interests and study areas) to develop multidisciplinary short courses about high school contents. By involving students of two segments: university and secondary education level, we intend to achieved not only the early identification of future students for engineering courses, among the skilled students at high schools, but also the consolidation of basic concepts that engineering students must have. On the process of seducing the students at high schools, showing the achievements you may reach through engineering use, the project provides both, actual and future students of UnB, a confirmation of their vocation. We noticed an increasing interest in learning and renewed motivation, as working tool to reduce the dropout rate levels.*

Keywords: *engineering education, dropout, meaningful learning-teaching, multidisciplinary, secondary education.*

1. INTRODUCTION

In Brazil, each year, about 320,000 students are accepted at engineering schools all over the country. From this amount, around 10% end their studies. Numbers referring dropout rates were updated at 1st September 2008 at Brazilian Technology and Science Ministry (MCT). (http://www.mundogeo.com.br/noticias-diarias.php?id_noticia=11800)

In 2006 just about 5.6% of all graduated students were at engineering correlated areas, what includes also architecture and urbanism.

Considering that 70% of Gross Domestic Product (GDP) growth is related somehow to engineers work, this issue needs to be addressed, if Brazil intends to resume its growth in a sustainable way, what implies in build all the necessary infrastructure as aimed by governmental PAC plan (Acceleration Growth Plan), and also face the challenge of compete in markets which products and processes have increasingly shorter cycles and higher competitiveness to guarantee the prosperity of the nation.

However, this will only be possible if solid and continued investments are made in training skilled workforce and developing a solution to overcome the issue of attract more students that must be motivated and ready to learn at engineering courses.

Most of these new students will come from Brazilian public high schools, which are far from the desired level of excellence. According to UNESCO's publication, access to high schools is considered very low – only 35% of all adolescents aged from 15 to 17 years old are enrolled in one – and access to higher education remained extremely low (Abramovay and Castro, 2003). Although the number of particular schools at engineering area is significantly higher as the public ones, Most of the students that reach higher education have a huge lack of contents from elementary education in which low quality level is evident. In addition, there are not enough teachers for the so called basic sciences of engineering, such as mathematics, physics, chemistry, biology and informatics, what obviously increases the problem of degradation of engineering education quality.

Brazilian scenario has yet a particular characteristic. According to data provided by SINAES (Brazilian National System of Superior Education Evaluation), at 2006, just 11% of the universities in the country were public, as can be seen at Figure 2.

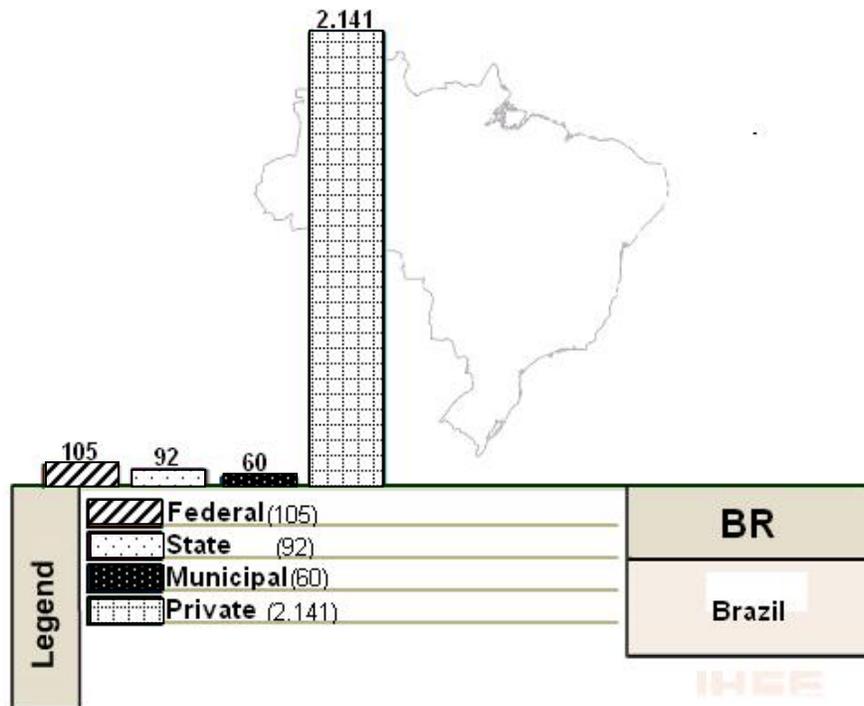


Figure 1. Brazilian distribution of engineering courses by institution category enrolment rates in (MEC/INEP, 2006)

Public universities are known by their high standard quality courses, therefore, the rates of enrolment at these institutions is much higher as the non public ones. Furthermore, following the market laws, because of the high competition, students that reach out a place at public universities are the better prepared ones, and most of the times the richer ones), coming from particular high schools, which offer better courses. So that, the not so well educated (and usually poorest), have to pay for their education at particular universities, what results in a very unequal distribution at enrolments among public and private universities, as shows Fig. 1, and even a higher level of dropout rates at non public schools (Table 2) due to the economical limitations of the students. At past years government started financing the courses at not public universities, but that is no guarantee of good quality education, especially considering the scenario previously presented.

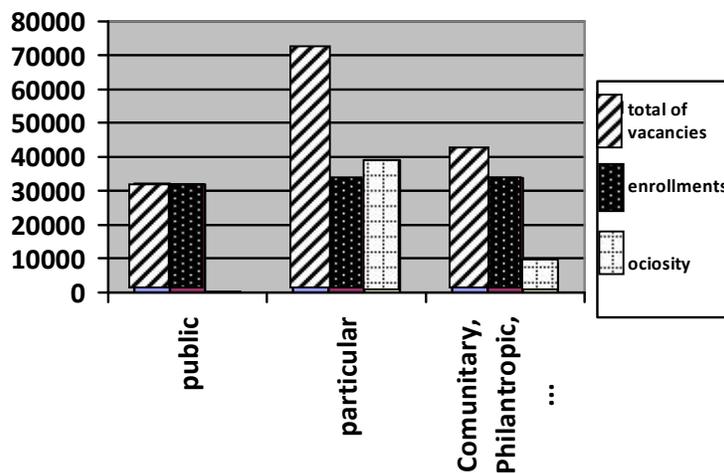


Figure 2. Engineering courses enrolment rates in Brazil (CGIE, 2008)

Table 1. Dropout levels at engineering courses by category of institutions (CGIE, 2008)

Administrative Category	% of Dropout
Public University	59%
Communitary/Philanthropic	75%
Particular	75%

This problem really must be faced, because it does not just impact the generation of new engineers, but all the skilled labor force what country will need as condition for fostering its full development, creating jobs and alleviating poverty.

2. BACKGROUND IN EDUCATION

There is an almost universal acceptance of the saying that “knowledge is a source of liberation of the people’s potential”. This refers to the knowledge that promotes links between human beings and the environment, between him and his fellows and with himself. The knowledge that promotes autonomy and connects the human being with his cultural background with respect to beliefs, values, feelings, attitudes, etc.. Working in the formation of the autonomous individual, when from its own knowledge structure, this individual is capable of capturing new information and learning from other similar circumstances, in a process of taking ownership of information and transforming it into knowledge. This is the knowledge we shall seek to obtain.

Furthermore, besides all particular conditions of educational systems all over the world, there is a new paradigm to face. Youth in our days represents a brand new kind of students; they are the so called digital natives. This new generation is becoming more and more diverse from the last generations. They absorb and process information in a different way. They are more accessible to audio-visual information, to quick stimulus; they can have multi task processing, they show no patience to learn over the traditional methods, and if so, this process is not really easy.

Our students have changed radically. Today’s students are no longer the people our educational system was designed to teach.

At his description of this new scenario, Marc Prensky (Prensky, 2001) describes: “Lest this perspective appear radical, rather than just descriptive, let me highlight some of the issues. Digital Natives are used to receiving information really fast. They like to parallel process and multi-task. They prefer their graphics *before* their text rather than the opposite. They prefer random access (like hypertext). They function best when networked. They thrive on instant gratification and frequent rewards. They prefer games to "serious" work. (Does any of this sound familiar?). Unfortunately for our Digital Immigrant teachers, the people sitting in their classes grew up on the "twitch speed" of video games and MTV. They are used to the instantaneity of hypertext, downloaded music, phones in their pockets, and a library on their laptops, beamed messages and instant messaging. They've been networked most or all of their lives. They have little patience for lectures, step-by-step logic, and "tell-test" instruction”.

The main challenge of building new learning objects seems to be the integration among attractive playful approach, towards to these new generation of students, and the concept of significant learning, what in fact, illustrates the core of the proposal. According to Ausubel’s theory of learning (Ausubel , 1968), prior knowledge of students are valued, so you can build mental structures in the implementation of new knowledge, based on their reality of life, allowing them to learn and rediscover the knowledge, characterizing an enjoyable and effective learning process. There are three essential requirements for Ausubel’s meaningful learning:

- 1) The new knowledge offered must be logically structured;
- 2) There must exist some previous knowledge at the cognitive structure of the individual that allows bonds to a new knowledge;
- 3) It is necessary an explicit attitude towards to learn and connect the previous knowledge to the one the student is suppose to absorb. This requires from the apprentices to be pro active attitude in relation to their learning.

3. DIAGNOSTIC OF SECONDARY EDUCATIONAL PUBLIC SYSTEM

In Brazil it has been difficult to convince teachers that the main objective of the educational process is provide students the opportunity to develop their skills and establish the process of building their own knowledge, helping them to overcome their limitations and encouraging the use of their abilities.

This is a result of a lot of factors that include the education which these teachers received, their work conditions, not to mention the cumulative effect of generations of degradation in the educational system. This scenario imposed to both, students and teachers, challenge them to survive high school, when the attempt of consolidation of teaching-learning process is as hard as can be possible, because of all the missing background.

The structure adopted at public high schools, consists in follow a pre-established class program, intending to cover the concepts mapped at the minimum curricula. It became a mechanic task, what can be resumed to the presentation of formulas and rules application.

The attempt of associate a formula to a phenomenon, that was not understood, usually leads the student to a path of frustration and lack of confidence. Students start to believe that they are not able to understand contents, and if in successful cases they can follow the mechanical process, usually they aren't able to use alternative methods to reach problems solutions. This whole situation provokes distortions in the learning process, and its results can be easily seen in the resistance and difficulty developed by most of students to learn simple concepts of physics, for instance. It becomes even worse when contextualization is proposed to introduce a problem. As students are just used to try to adjust given numbers and parameters in the formula to get a solution, to relate a physical phenomenon to their daily lives events seems to be very hard.

On the other hand educational system is so deeply bankrupt, that even if students get to understand and create cognition bonds with the phenomena and daily situations, it won't really help the problem. For most of the students reading and comprehension of texts that present the problem isn't easy. And the next challenge is right there when this step is overcome. The simplest mathematical procedure is not well-known enough to allow them to handle formulae.

Unmotivated teachers and students with a huge gap in their necessary background and that are skeptic of their learning ability. This is the setting PRECOCE needs to address its proposal. That forced PRECOCE to cover areas that it was not supposed to, such as Portuguese teaching (reading and comprehension and basic mathematics, from fundamental cycle).

4. DIAGNOSTIC OF UNIVERSITARY PUBLIC SYSTEM

Panorama at the public universities could not be that different, once students that managed to pass the entrance exams came from a system where the average level is not different from what was described above.

At present days, less than 5% of students at public universities come from public schools, since they can't reach the minimum level required at access exams. However, considering new politics for access to public universities, it will be compulsory that at least 50% of students are going to be provided by public high schools, no matter what grades they have related to the previous system.

Students with lack of necessary background to support their evolution in the courses and a few number of laboratories for graduation level (that would allow them to relate the new concepts to experimental tests), summed to the distance they have from the core of their engineering courses, once they need to get all the basis first, is a source of demotivation and main reason for dropouts.

These students are going to need a better support to overcome the missing background that will allow them to deal with their new reality at university, what includes following classes what presents contents in a so different way they were used to. Motivation to learn seems to be the key word. They should be able to recognize the importance of the effort necessary to adapt to a new level of learning, in order to be successful at the future profession they are being prepared to have.

In most of cases this doesn't happen. Students cannot see the importance of this basic structural knowledge to their careers, or aren't just prepared for it. That, summed to the fact that they were not really prepared for choosing a profession so early, increases the dropout's levels.

This is the scenario for PRECOCE at UnB.

5. PRECOCE'S OBJECTIVE

Pilot Project PRECOCE (Project of Continued Education in Engineering Basic Sciences) is a response of University of Brasilia (UnB) to a governmental supported program named Innovating Engineering (*INOVA Engenharia*), presented in details at IEL's publication (IEL, 2007), which intends to work at political and executive levels to provide more and better engineers to support Brazilian development. To achieve this goal, it refers proposals for modernizing education system.

PRECOCE's main proposal is to promote engineering and improve quality of learning-teaching process, in special to the sciences in which engineering is based at, through a playful approach by means of integrating university and secondary school communities to develop collaborative projects. This contact also permits to improve teachers' continuous educational process.

Insert students from secondary level at university environment is one of PRECOCE's strategies to help them to make a more solid choice of their future career. Student can come to project's room at university and help university

students from several different institutes and departments, to develop kits for helping learning process, or learn how to use simulation to model and solve a problem, or yet, be a trainee at one of the engineering laboratories.

Although seduce students to engineer careers is one of project's main goals, seduce is not enough, this student must be able to pass the exams to become a student at public university. This for, its necessary provide them with enough knowledge to allow them to succeed the exams and also be able to go ahead in their studies at university.

Student's learning must be consistent; he has to become motivated and capable of learning as part of his life, not just at university, but to face the dynamic of modern life, which requires the permanent ability of learn how to learn.

But it's not just the technological concepts that must be learned. The challenge includes coaching this future professional with a perspective of sustainability for development and of social responsibility. These concepts must be part of them as individuals for a new world.

6. METHODOLOGY

In its methodology the project includes actions that aim to disseminate to students of public high school the work of engineers, design and engineering challenges overcome through the combined use of "feared engineering sciences", namely mathematics, physics, chemistry, biology and informatics and the new challenges presented. There are initiatives for improving the teaching-learning materials and those for the inclusion of students in the university environment, through training in groups of transdisciplinary projects and laboratories in graduate education.

The initial proposal of PRECOCE was to establish in a partnership with teachers of high school and the community of university, the development of courses to improve teachers' qualification and extra class activities to the high school students, with teachers full participation and adopting a new methodology, in an attempt of change this paradigm by developing a learning process capable of awareness, motivating and involving the student for learning, expanding the size of the specific contents of the various curriculum components, including actions that allow the development and exploitation of social and intellectual skills, improving the teaching-learning process.

However, soon we realized that despite the previous agreement to the proposal, most of teachers are not really interested in participate of such actions. They refer that salaries are not a motivation to change, and students have a serious lack of background, what would not allow such effort to achieve the intended results.

As alternative, we started working with students of university preparing the learning objects for introduce a new way to learn each curricula item, and associated to each subject another that was closely related. These courses were revised and discussed by professors from different areas at university and the offered to the high school students. Establishing a direct tutorial process, among students from university and high school students.

In summary, methodology consists in follow a playful and multidisciplinary approach to present concepts. A hands on way of learning precedes the presentation of any formula. Phenomena is seen, experienced, discussed and understood before being related to any theory. Connections among each phenomenon and daily events is constructed with active participation of students. Using low cost artifacts, kits are built to show, for instance, a physical phenomena, then a discussion about that phenomena is made, and the students make the correlation among that subject and their previous knowledge and experiences, then several other areas of knowledge (such as mathematics, portuguese, geography – as much as possible) are related to that subject.

The mini courses are faced as "time to learn". Aspects of mathematics, sustainability, chemistry, physics and biology area addressed in a course of "Production of Soap", for instance.

Games and competitions are used to provide additional motivation. So a contest to choose the best "pasta bridge", (built in a course of statics), or another to choose the best construction of a machine (built from the application of concepts of dynamics), or even a karaoke class to learn English are used as tools to improve teaching-learning process.

The construction of knowledge in group work, using a game based approach, allows the students to interact in the process of sharing their previous experiences in a synergetic process.

According to Galarneau & Melaine (2006): "The modern world requires that knowledge not be limited to one individual's thinking, but rather shared and accessed in a variety of ways. It is our collective intelligence and the communication bridges from one individual to another that represent the possibility of an exponential leap forward in terms of knowledge capability on a large scale".

7. PRECOCE'S ACHIEVEMENTS

PRECOCE started its activities as registered activity of extension from UnB in the second semester of 2007. At this first semester, 2/2007, there were about 10 students from all departments engaged in the project's actions as tutors, and 19 high school students coming to help and staying at UnB with their tutors (being 15 with financial support from FAP-DF, the Research Support Foundation, from Distrito Federal), at the following semester, 1/2008, this number raised to 16 university students, and 6 voluntary from high school, at present time, 1st semester of 2009, there are 44 students from UnB, from graduation, and post graduation levels, working as tutors. The level of commitment of these students shows a very high level of satisfaction with the activity they develop.

At the project, students of both segments (university and high school) develop beyond the cognitive process, skills and competences relating to perform tasks in groups, conflict management, speaking and writing, to become active agents in the teaching learning process, participating in the development and improvement of "workshops" and its reproduction to the level of education immediately prior to his. Students in high school are encouraged to make the same learning objects, using an appropriate language, to the students of elementary school.

Students from UnB, have the chance of learn better contents that were not really understood and develop their skills towards to pro-activity, improvement of ability to speak in public, to teach, to prepare their material and check its quality previously, to respect schedules, to compromise to a project goal and act as a group member.

Along the year a series of speeches, many of them given by students from engineering courses, reporting their personal stories and how they found out that the power and beauty of engineering, as a tool to promote social equality, and distribute wealth, are presented to the high school students. During the process students are lead to understand and appreciate the work of engineers, how the knowledge that seems so far from their reality can have a huge impact in the life quality of populations. Applications are presented referring to the sciences that they are supposed to learn, improving their sense of the importance these sciences can have. At these events many of the university students have the chance of fall for engineering as well as the high school ones.

Along these years, 5 of the 15 students from high that at second semester of 2007, were sponsored by FAP to come work at UnB are now studying at University of Brasilia, from these 3 are now tutors, one of them decided change his course (Mathematics) to Mechatronics Engineering, and is now developing activities of robotics with secondary students and teachers, one of the students was awarded with 1st place at a FAP's contest as Young Inventor 2008. Our partnership with CEM01 (Center of Secondary Studies Number 1, at Sobradinho, DF) opened a great opportunity to these youth to experience projects in Mechatronics. At 2008 there were 70 students working at opposite turn at PRECOCE's laboratory at school, under supervision of their teacher Jacó. This year he has about 50 students developing projects that include robotic vehicles, and recognition of patterns thru computational vision programs use, associated to other devices. From these 70 students that were working with him, 10 are now at engineering courses, 3 of these at University of Brasilia and 1 studying at an Argentinean university. The winner of FAP's award is preparing herself to the exams of UnB at Electrical Engineering Depth.

Working daily with these students has shown that they get very interested by studding when some application is added to it. Their commitment to their courses seems to improve, and as much as they can they come spend time preparing their workshops, what means extra study time.

Table 2, following, presents the results of a inquire applied to the university students about how PRECOCE have impacted their studies at university, it contributed to reaffirm their certainty about their choice for the course they have choose, and how it is helping the development of complementary skills.

The next seven questions were to be answered, with numbers from 1 to 5, meaning 1 – not related to my case, 2-5 as an amount that is at range from 0% to 100%:

1. Do you think that PRECOCE's participation helped to make sure the course you are studying is what you really wanted?
2. Do you think the presentation of workshops was useful to help consolidate concepts needed as background?
3. Do you think the activities you developed at PRECOCE had a positive impact on the achievement of additional skills as, for instance, the self confidence necessary to speak in public, or the ability of work in groups, or the ability to manage conflicts and motivate a team?
4. How would you describe your interaction with secondary students to implement the workshops? Did you fell that they were receptive? Did you fell that they were able to understand better the contents you presented?
5. If you are a student preparing to become a teacher, did you fell that your experience at PRECOCE helped anyhow your training to your future profession? Please write a commentary about.
6. Do you think the activities at PRECOCE had a positive impact on your performance in college?
7. If you attended any of the workshops offered by other colleagues (tutors), do you think that you learned from this experience, whether absorbing the explored contents whether from ability of the tutor showed to present it?

From 45 students, 30 answered the questions resulting in the data presented at Fig.3. These data was consolidated not considering the answers numbered as 1 (not pertinent question).

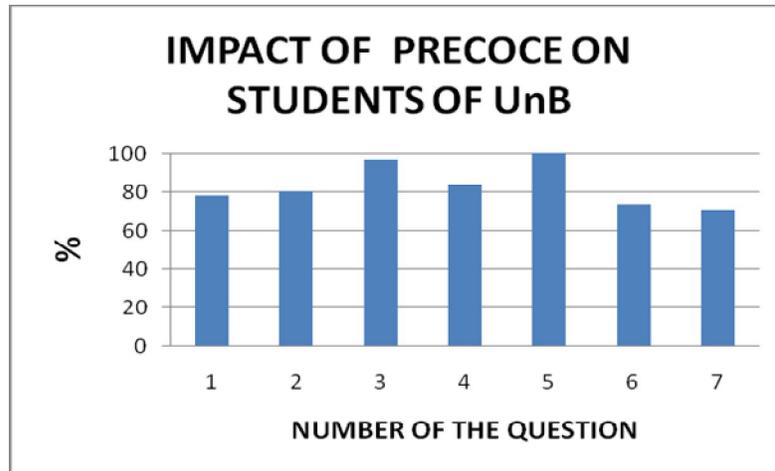


Figure 3. Percentage of impact PRECOCE had on university students, measured from the questions answers.

8. CONCLUSIONS

It's possible to affirm that a solution that might guarantee continuity to provide engineer students which are necessary to develop Brazil is possible, despite the low quality of the previous education they had, and the apparent inability of educational system to overcome the problem.

PRECOCE shows that its proposed methodology, using the tutorial system, which promotes the integration of high school students into the university environment early seems to be a solution that have a collateral benefit, which is to improve the level of commitment of university students to their courses, and by the fact that they become so motivated to produce the workshops, that will result also in a extra time dedicated to their studies. And is a kind of study they do with lots of fun. This kind of integration to the students from the first years to the ones that are at more advanced years shows them the skills these students developed and the importance of a solid background. Besides, complementary skills are also trained, so that this student become more pro active, independent, self taught and they sure learn quick from each other, what under the correct supervision means a huge improvement on their knowledge.

Furthermore, students from high school have shown great interest in learn since they start to experience and create bounds with the contents they are taught and their daily lives. Thus, even when other barriers are still to prevail over as the read and comprehension and basic mathematics skills, they seem tempted to try and learn more.

9. ACKNOWLEDGEMENTS

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