

Improving Science Education Through New Perspectives

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Abstract—The demand for engineers has always been high in growing countries, however, the world's seventh largest economy, Brazil, is still far from being one of the places with highest development in engineering. Through the normal curricula, high school students often learn theory only and investment is not made in the practical part, as a consequence the interest in engineering is low. Creating a design focused on the practical application of basic concepts of mathematics, physics and chemistry using simple materials and with an easy access to high school students is really important, as the goal is to get them interested in the field of science and technology and this action will improve their quality of life. The motivation and realization of an engineer will cause changes to society. The development of humanitarian engineering projects can help in the reduction of the number of social problems such as slums, sanitary issues - which are very common in global cities like São Paulo and Rio de Janeiro – and water shortage – this kind of problem happens in cities located in the Brazilian Northeast Region – as there isn't a proper water distribution system. .

Keywords— *Education, Volunteer, Project, Engineering, Humanitarian.*

I. INTRODUCTION

The study of the sciences has always been considered by many Brazilians to be challenging, so there is an antipathy against such subjects. This concept has its roots on the beginning learning process's construction in the field of science and mathematics in elementary school, which ends up being reflected until future years and, in most cases, influence the student's carrier choice for its future..

The lack of investment in education in Brazil is notorious as to evaluate the current situation of the schools,

which are scrapped like an old vehicle that has been put away by its owner and they have no incentives. There's a lack of interest for some subjects that require a practical explanation, as there are no labs. For those reasons, public school students are increasingly at a disadvantage when taking an university entrance exam in Brazil, once compared with private schools ones.

There's a high competition when joining an engineering course, which discourages these students that are trying to pursue this career, but that is something this project aims to modify. This big contest to take an university course's offer is a consequence of the high demand for engineers when compared to the low amount of graduated students. Furthermore, engineers have a high wage, therefore there are many people looking for an offer to take this kind of course .

Professionals working in engineering are so important to the nation, but the number of graduates is far from ideal, therefore foreign workers are required to fill up the job offers, instead of Brazilians ones.

The project's goal is to encourage young students from public schools to go for engineering by creating a greater interest in sciences through practical activities with easy access and low cost materials taught by teachers, also by trying to minimize the lack laboratories. Volunteers of the IEEE's branches would train those professionals to be able to do these activities in their proper classrooms, through a conference, covering a large number of students in the region this project will be acting.

Based on the worldwide program of the IEEE, the TiSP (Teacher in Service Program), the activities developed by various authors around the world have been selected. Activities to be applied for students that are from 15 up to 17 years old were selected to be introduced to the teachers. Then

they felt a great enthusiasm to pass those concepts on to their classes.

The region of the Paraíba Valley, where Univ Estadual Paulista – Guaratinguetá Campus is located, is a center of excellence in the technology industry in Brazil. And it still needs more skilled labor and a greater number of graduates in technology. Thus, the presence of professional engineers in the locality is of great importance. For this reason, the implementation of the project was held in 2013 by the IEEE Guaratinguetá Student's Branch as a pivot to be widespread in other regions. Their results and their importance in society will be discussed in this paper.

II. EDUCATIONAL CONTEXT

The method of student learning is directly linked to professional's training, who is leading and teaching the lesson and is the one who helps each one its learners to get the interested in learning. However, in Brazil, the teacher's poor training and their actual wage rate make them become discouraged, causing a drop in the quality of the courses they teach.

The lack of infrastructure in Brazilian public schools is a consequence of the investment of US\$ 2.3 billion that government makes in education, getting behind Transportation's investment (US\$ 3.43 billions) and Defense's one (US\$ 2.44 billions) [1]. Those schools appeals to the government for funds so they can improve the working conditions of teachers and staff, since those conditions have become extremely precarious.

Labs are an important tool whose function is to introduce the student to the application of theories and concepts seen in a classroom in a dynamic and interactive way, promoting the absorption of the knowledge by the student. However, such laboratories are not part of the reality of most of the Brazilian Public Schools, due to the structural problems faced by them.

According to Piaget, "The cognitive imbalance works as a ground for learning and each new situation contributes to the promotion of development. Knowledge and development processes are two sides of the same coin, they are getting established mutually. "

The human being is able to select strategies to be able to learn and solve their needs, through challenges and practical situations. It is the educator's role to stimulate what induces reflection, thereby building a critical, active, reflective and confident person.

The challenge of organizing a pedagogical practice is mainly linked with planning in modern times, it is necessary to develop activities that challenge the students and promote construction of autonomy, interaction and cooperation. In addition to that the articulation of teaching objectives and the organization the proposed work space basis is required, developing them them.

The possibility to provide the human a learning experience that will influence throughout their lives, as a critical person will know how to explore, analyze and take a reflective look in society.

III. OBSTACLES ON ARRIVAL TO HIGHER EDUCATION

Brazil has high-level public colleges and universities, totally free, which have restricted seats that are wanted by most of the Brazilian students. But also, there are private ones, whose courses's quality can be considered to be good or medium and the greater is the market demand, the more expensive is the course (for an example: a medicine course costs around US\$ 2,000.00 per month and an engineering one is US\$ 910.00 per month), so consequently poor people can't get into those institutions, as they couldn't afford a high-quality graduate course, in the other hand, students from private schools are more prepared to take all the available seats in the best universities or colleges.

Among the most targeted courses are the engineering one, having a average demand above the other courses. Moreover, the engineering course is also famous by the salary. The minimum wage of an engineer is relatively higher than many other professionals's wage, that's why there're many people looking to pursue this career.

In São Paulo, the richest state of Brazil, is where the most public universities are located: the University of São Paulo, Univ Estadual Paulista, State University of Campinas and the Federal University of São Carlos. The engineering course has a high number of applicants making them the most competitive ones among those offered in the country.

In 2013's entrance exams, the electrical engineering course at UNESP's Guaratinguetá Campus had the number of applicants per seat rate of 15.8 [2] while in private universities, the demand reached a maximum of 7 applicants per seat.

Brazil relies on bringing professionals from different countries such as Portugal, Italy, USA, among others, because the country doesn't provide enough engineers to accomplish local market demand. According to Ivan Witt [3], director of human resources at Stter RH, "There are around 32,000 new engineers a year in Brazil and only the auto industry and Petrobras (Brazil's national oil industry) demands 34,000 engineers. "

The number of graduate students is low when compared to to the high demand for engineers, as a consequence students with low-income that could not get into a public university will give up on studying and not persuing to work on high-wage professions, so they will start looking for cheaper courses with less competition in entry exams.

Due to the lack of investments in Brazilian education, the country occupies the 64th position among 142 nations evaluated in the overall innovation Index. [4]

According to a study conducted by the NGO Educational Action and the Paulo Montenegro Institute, 64% of the Brazilian population has none or basic scientific literacy, which prevents them from interpreting terms and basic scientific concepts. And that issue prevents scientific development in the the country.

With a low investment in education and innovation, the study shows that, instead of innovating, the students only replicates the knowledge, due to its deficient educational system that does not encourage the generation and application of knowledge.

IV. THE PROJECT

The STEM fields are classified as very difficult and challenging by most of the students. Also there's a lack laboratories for these subjects in most of the Brazilian Public Schools, what makes the theoretical learning process monotonous and tiresome.

Experiments have great importance in the construction of learning programs. Having that in mind, the student is asked to investigate a problem and observe the phenomenon studied in class, then proving theorems, laws and axioms.

The traditional books feature the content by means of mathematical deductions, which generate the formulas that, in most cases, are just memorized to be applied in any situation.

With practical application, the student will be able to apply such deductions in way to understand the causes that result in the the constants and variables to be included in the equation. Now it is possible perceive, denote and absorb the knowledge with this method, in instead of memorizing things.

Based on this situation, the project comes up as a way to assist educators to increase the interest of high school students in the subjects of Physics, Chemistry and Mathematics, which are in public schools's curriculum. Its scope can be applied worldwide, targeting places where there are no large investments in education, linking the study of science with daily life.

The idea is to apply engineering's theoretical concepts in students lives, in such a way that they will make the daily lives of those people easier, at the same time it will be showing that this field of education in general can be useful and even be something easy to apply on their every day, revealing the exact field goes far beyond the theoretical concepts seen in a classroom.

In order to achieve this objective, the IEEE Guaratinguetá Student's Branch develops simple activities with teachers, that work in public schools, in order to show them the engineering and technology concepts applicability a in projects that involve physical structures, electricity, magnetism, and robotics technologies.

This project got out the paper in 2013 along with Pr. Dr. Rubens Alves Dias (Student Branch Counselor). It was

presented to teachers from municipal schools in Guaratinguetá. The projects used materials easily accessible in order to be applied in their classrooms.

Teachers were invited for a meeting in which the activities were demonstrated. It is estimated that each of the teachers, who were in the event, taught an average of, 240 students, and almost 7,000 students from municipal schools located in the city of Guaratinguetá received the information passed on those projects and they started to notice the different way in which those subjects were been taught .

70 participants were teachers at all in the beginning, then they instructed other 2,000 teachers, as a consequence almost 70,000 students from public schools were been taught in the new learning method.

One of the projects included cards, scissors and tape, then the teachers were organized in groups and encouraged to create structures that could support the maximum load. In the end all the physical concepts involved in the process were revealed, in such a way to demonstrate the application of these same materials that were given in the beginning.

Another activity that was developed with the same teachers was a practical presentation of concepts of voltage dividers and current, using batteries and LED's. This project demonstrated the differences between series and parallel connections.

The number of students interested in studying engineering is expected to grow, as they learn what those workers do and how many of them are employed.

V. OPERATIONALS ASPECTS

The TiSP has been used as the basis for the program, through the project undertaken by IEEE. The adapted and developed activities will be used to enhance teaching, promoting improvements in the creation of classes and in the interaction between teachers and students.

The idea is to call the local teachers from the city or region for a conference. On that event, the volunteer from the IEEE student's branch would present a theoretical basis containing the importance of administering the "hands on programs" in their classrooms and the concepts of activity that will be carried by them afterwards. Then those teachers would divided in groups for the development of a marathon. In each one of those groups, importance of teamwork would be stated to the teachers, this will help in promoting the interaction between people and discussion among divergent opinions, to be disseminated in class later on, as those are fundamental concepts for the development of students.

Teamwork makes students exercise a set of skills. While studying the content of the subjects, they learn how to make evaluations and to take decisions. In those tasks, the ability to listen and respect different opinions is comes up in the game. Also, the ability to learn arguing and dividing tasks will be required, once the students become professionals.

Vygotsky's social psychology theory states that learning always includes relations between people. He defends the idea that there is no development that is ready or planned that will get updated as time goes on inside of us. The development is seen as a process, in which the organism's maturation, the contact with the culture produced by humanity and the social relations that enable learning are present. It means that the development is a process which occurs inside out [5].

In a group activity, it would be distributed simple and easily accessible materials. At first, it seems like it is something that was randomly chosen and they have no application. The challenge is to complete the given exercise with those materials in the most creative and dynamic way. The required materials can be found in any place at a low cost.

Each project has a method with which you can get the best result, the goal is to discuss why one group's method is better than other ones and to point out the differences between them. After each project is done, all of them are tested in order to verify and discuss whether the mechanism of each group is efficient or not.

In the end of the project, there's a debate among the teams about the procedures that were used through physical and mathematical deductions. Afterwards the best way to accomplish the project is exposed to the public.

VI. RESULTS

After being applied to teachers, the Student Branch of Guaratinguetá contacted them, in order to request a feedback about the project. The opinions received were mostly positive in relation to the activity, many teachers got interested, then they provided suggestions for program improvement, such as the creation of a guide book and an experiences data.

It was requested by the Secretary of Guaratinguetá's Education for the project to be relunched to a greater number of teachers from the region on the second half of 2014, having larger structure and renewed activities. Due to this fact, the project got famous in the region, and it is spreading still.

The number of students reached by the implementation of the project, has made it extremely large, as a result it is already surpassing the limits of the municipality.

This project has no social benefits only, it also has financial impacts on the lives of those people who are benefited by it in two ways.

The first one is a consequence of the deployment of engineering techniques that were learned in class, by reducing daily maintenance costs and expensive equipment that were purchased before may eventually be replaced by more affordable options produced by the people.

The other benefit can be seen on the students who have joined the project, as they have found out that the exact science subjects are more simple and useful than the previous concept, so the learners feel more like studying those subjects

that, generally speaking, are the major entry exam villains, as a consequence the chances of this joining a public college without needing university entrance preparation course are greater, so that each family gets to save about 5,400 dollars.

The results obtained from the project can only be seen in the next entrance exam for university which will happen at the end of 2014. But through research done in one of the schools which the teachers attended the conference works and passed these teachings to students, it can be seen an increase in the interest of the students for the sciences subjects and wanting to pursue careers in this area.

A number of 240 students completed the questionnaire. Before the project, only 25% of these were decided on a career in the field of exact sciences, 45% stated that they would follow other careers and 30% had not yet decided. After the start of the project, 40% wanted to pursue a career in the exact sciences, 35% wanted to pursue careers in other areas and 25% had not yet decided.

In general, the increase was significant. The project was able to demonstrate to the teacher through numbers that these new ways of explaining the exact sciences have a good result attracting more people to the area and getting to address the lack of laboratories.

VII. CONCLUSION

It is possible to disseminate scientific concepts not only for students but for the entire community through the project, showing that engineering goes beyond complex subjects and it may be palpable when applied on someone's every day life.

The students who have this new vision of engineering through the application of our project started to take those new experiences to their homes and friendships cycles.

This interaction among people influenced by the project starts to create in the community a different view of engineering, a vision of something that goes far beyond the ideas, subjects and expertise to many human beings.

Also the inaccessible and becomes something tangible and applicable in our day-to-day activities, thereby those people started to see the sciences and engineering as something less theoretical and more practical.

This volunteer work was not dignifying exclusively for those who had the opportunity to teach it, but it has also brought new and different experiences for those who were able to go far beyond from just absorbing knowledge from this extremely active interaction with those who were there only to learn.

For Piaget, "The main goal of education is to create men who are capable of doing new things and not simply repeating what other generations have done. Men that are creators, inventors, people that discover new things. The second goal of education is to make up minds which are able

to criticize, verify, and not only accept everything is purposed to them."

Besides showing the different face of the exact sciences, the design forces people to use their creativity in order to create something new, making this new learning experience even newer when passed away from person to person, therefore creating more active minds that urge to change and create things .

Such encouragement to the discovery and creation automatically improves the people's lives affected by the proposed project, in a way that those humans are willing to create and modify the environment in which they live, in order to make it more practical and, automatically, more enjoyable. Furthermore this can solve many problems of every day life in a creative way.

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