Building a New Education Environment

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Abstract

The process of university teaching and learning nowadays is continually changing, strongly looking for some effective stable methods due to the current information age. Our proposal is mainly focused in transforming the traditional classroom into a workroom by reproducing inside, an industry-alike environment. Every educational activity in the workroom is developed following industry goals and policies, as consequence of having the making of a product as a final target. Thus, this workroom-based education is a complete development exercise, like we could find in a startup company. All this generates a new level of academic results and goals.

We have implemented this method in a set of courses of our undergraduate Systems Engineering and graduate Computer Science programs at the Universidad de Los Andes, Venezuela. Herein, we will use the experience in the workroom of the course "Introduction to Programming".

1. Introduction

We believe that industry environments are better adapted today than university´s in order to accomplish the mission of education. Education has moved onto another reality context where the current state of the internet and available tools are pushing-off the traditional teaching activity, and bringing in the making of a product. The impressive information domain around our workrooms transforms its environment to be a capable and knowledgeable force for the development of any product related to the course being taught.

We will show here the experience in the course of Introduction to Programming (first semester in a five year program) taught as part of the Systems Engineering major at the authors´ university. The immediate result was an apparition of a fast-lane learning, a great level of motivation, and creativity by developing a product under an industry-like organization within the school environment.

2. The School Information Age

Today, the information needed for students to prepare their demanded knowledge in a classroom could be defined as totally handy, thanks to the internet. By this, we are saying that students could find the central theoretical information and its explanations in the internet, i.e. [1]. Not only the information could be found, but a number of views of the same information offered by different people from all over the world. For example, today teachers could prepare their classroom slides by retrieving slides from other teachers' web sites, or even better the whole class program available from a good increasing number of universities world wide, i.e. [2]. Then from the internet, students can comfortably capture a given homework developed with the exact answer, or navigate at the same time, the same material being taught in the classroom thru a cell phone or laptop. We are aware that these last examples could have happened in the past from other sources like books, classmates, or colleagues, but we all know the increasing factor in many ways of this reality with the internet. Not only with the space of people but with the space of possibilities produced by the open characteristic of the internet. We don't need, for example, to acquaintance the individuals to request the needed information. It's a very large open data world, making the information totally handy. We call this reality TGIA (Total & Global Information Access), keeping the distance to the current truth of today's access of global information, i.e. [3].

We could add the following, professors in the traditional classroom teaching environment build some virtual walls around the knowledge being taught (teachers teach what they know or rather, what they remember). These virtual walls define then, the knowledge domain degree for the corresponding course. On the other side, the internet, generically speaking has no walls. It's an ocean of knowledge with

respect to what is viewed in a classroom. The internet becomes a tool for students to demolish any limiting knowledge wall created in the classroom. We call this reality TGIF (Total & Global Information Forms).

Thanks to the above realities (TGIA and TGIF) of the school information age, we establish an important new world wide reality of today's teaching: we are teaching classes totally composed of full-bright students, idem to say classes are full of information-based. Therefore, it becomes mandatory to move the teaching activity from the today's isolated field education form to an integral sphere one. We believe that the industry-like environment, which incorporates social and collaborative activities, could be that new education sphere.

3. An Industry World for Education

We are recreating this industry-like environment in a number of our undergraduate System Engineering and graduate Computer Science courses offered at the Universidad de Los Andes-Venezuela.

The methodology is based on a synergy between the following two activities to recreate:

A. The development of a design exercise in the classroom by the teacher;
B. The development of a product under an industry-type working organization within the school walls.

And the buildup of a complete workroom environment to excel the above mentioned information age (see pt. 2.0).

The idea of transforming a traditional classroom into a workroom simulating a business environment (industrial), in which the activities follow the policies and goals of the industry for a product, necessarily involves incorporating teaching strategies with a social constructivist approach, enabling a collaborative learning.

The exponents of constructivism suggest that through manipulation of the objects are a better learning, that individuals do learn by experimentation and not because they explain what happens. In constructivism, knowledge is actively constructed by cognoscente individuals who see their own inferences, discoveries and conclusions. For constructivism, individuals learn new information presented to them by building on knowledge they already have. [4].

Authors such as Piaget, Bruner and Vygostsky incorporate social and collaborative learning. [5] Thus, social constructivism defines that the most optimal learning environment is that one in which there is a dynamic interaction between actors and the process which individuals create their own truth through collaborative activities.

It should be noted that the educational influence is not restricted to the teacher-student interaction. In this case, for the construction of meaning, interaction among peers, among students, is recognized as a social context. In this interaction mechanisms are put into clear confrontation of views, problem solving, and brain storming, among others. [6]. These activities are common and daily basis in an industry environment.

3.1 Implementing the New Education: Introduction to Programming I.

We will describe here the new method of education thru the experience lived with the class of Introduction to Programming I (IPI) [7], given in the very first semester of the freshman year. The IPI class then, it is mostly composed by students with no knowledge of logic programming, let alone of software simulation.

Based on the constructivist approach and collaborative learning the workroom industry alike class has the following characteristics:

- The teacher is a promoter of development, therefore must empower students.
- The teacher is a facilitator of learning.
- The role of the teacher is not to convey information.
- The teacher must create an atmosphere of affection, respect and tolerance.
- The teaching strategies should lead to collaborative learning meaningful.
- The work environment should simulate an industry environment, in which the level of demand is high; high motivation, and zero tolerance for excuses.

The new education method starts in the very first class, when the teacher informs the students the new schooling idea, policies, and the industry-like organization. The following week, students handle-in the structure of each company, and very important, the name of the company. We formed ten companies and were offered to develop the same product with a slight diversity. The product consisted in developing in language C, a simulator of a set of traffic lights of the city (see Fig.1).

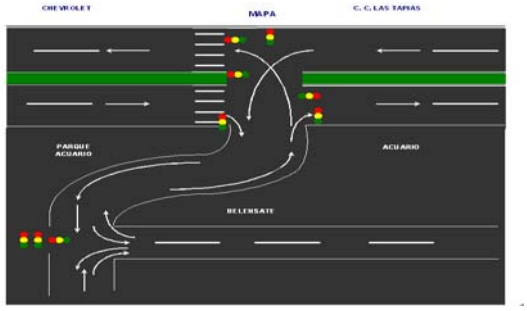

Fig. 1. The product: A double-traffic light simulator.

We present the complete program to study in IPI through the class activity of developing a set of programs from the very first week, following the introduction hours of the course material. The creation of the code in every teacher oriented class has the natural angle on working out the programming techniques, terminology, and/or concepts set as education goals in the IPI area. These explanations were highly motivated for comprehension; as they appeared in the nick of time for the different IPI subjects under consideration.

The actual development of a computer program consists of defining: Its goal; the input data structure; the output data structure; the algorithm; and the coding and validation. All this is work out in the classroom in an integral form. We believe that by going directly to the design process from the beginning of the class, teachers are more proactive on the different subjects of the program by being more precise and focused. Moreover, injecting a very productive and motivating environment generated maybe from the feeling of weekly success from the project growth, the closeness to the real world (engineering work), as well as living a fast lane knowledge understanding. This interaction among students and teachers is an impressive non-stop creativity and productivity generated by this industry-like experience within the university surrounding.

We have been surprised in these past two semesters to find out that we go thru most of the IPI program in few weeks of the semester term. Definitely, some units remain weak for a period due to the entrance point of the process of computer programming (i.e. loops before file management); but we all know that this is impossible to avoid.

From our experience, teachers easily identify these weakens areas, and then, start to react on the computer programming evolution in class in order to meet and work the different subjects being behind.

In this way, teacher has to develop a series of activities involving, among other things, interactive and collaborative action plan to foster motivation and student participation. Teacher has to relate their teaching with learning objects that students must internalize, identifying clearly the learning and incorporating technology tools to achieve the competencies established.

4. The Industry Policy in the Classroom

We grouped the students as simple startup companies of 10 members each where its internal organization was defined as follows: One director, three managers, and six engineers whom were assigned in pairs to each manager (the numbers of students in the lower hierarchy could vary, keeping the presence of only 1 director). This industry-like structure was left to the students to select the team, and the assignment of every position.

4.1 Initial Policies

The first policies given are that the teacher is the Chief Executive Office (CEO) of all these companies and the CEO will meet only with Directors outside the classroom once a week. This special meeting is needed to push the information and to push the industry environment to the students. We start by publishing some of the main rules-of-law in this method, they are:

a) Zero-tolerance to excuses.
b) Mandatory presence to the Directors meetings.
c) Competition for grades among companies.
d) Directors could be fired (changed) only by the CEO, or they could resign.
e) Other changes within a company are isolated to the CEO, but needs to be notified.
f) Any request from a company to the CEO, could only be done thru its Director.
g) Every evaluation done in the classroom related to the product will reflect a personal note and a company note. The latter will add some points to the personal ones only to those individual who form the best overall company. No punishment is done to the worst company's personal grades.
h) The aggregated final grade given to each company values 1/3th of the overall final student note.

These policies are specified, explained, and established in the classroom during the first weeks of class, as it was mentioned before. We find important to work out with the students the details of each policy given above for clarity and to ignite an entrepreneur aptitude in each individual from the beginning.

4.2 The Weekly Directors Meeting (WDM).

We define it as the control knob of the industry-like environment. It is the secret tool of the methodology. If we degrade the value of this meeting, the livelihood of the environment that we want to reproduce degrades, as well among students, and mainly among the companies.

The values of the WDM are translated by the execution of the meeting, by the presence of one person of each company (mandatory to each director, but in case of impossibility to assist, a representing person must be in), and by the exact execution of the weekly requested tasks which translate into the effective progress of the project, like we could find in the industry environment.

For example, the CEO-teacher requested to all directors to define the input data structure for the double-traffic light simulation. Each director came with a proposal from his/her company to the following WDM where they ended up with its final definition shown in the Fig.2, after a deep and long discussion. Every director was requested by the CEO-teacher to sign-off the datasheet of the final input data structure.

This strategy helps to develop competence. For students working in the design of the product is aimed at increasing their knowledge and ability in the discipline of content.

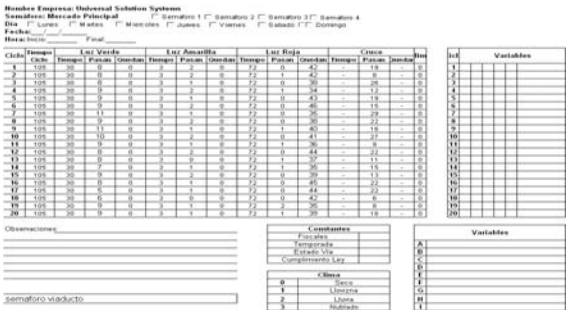

Fig. 2. Input data structure for the traffic light simulator.

In the meeting, directors quickly learn and adjust from the kind of smooth school way to the zero-tolerance to excuses in the industry way. Directors propagate this shockwave to their peers, and the company structure starts to appear among them, instead of a more global form of a group. This is also supported by the teacher in the classroom by taking some of the hours to workout some products related, and company policies. We have also found out that admitting some director's companions from the companies at the meetings help students to quickly adjust to the industry rule-of-law.

Moreover, the meetings help the students increase their knowledge and ability to undertake a challenging task that requires a sustained effort over the semester time. Each companion group of students learns to take responsibility individually and collectively for the team to successfully complete the product.

4.2.1. Four Questions on the Progress Report, One Leap for the Project.

In each weekly meeting, directors are asked four questions by the CEO, and they are:

Q1. What have you executed from the last week defined tasks to do? Each item that was written-off the precedent week to be executed is valued and quantified for finalization. Each item is given a color to explicit the state of completeness.

This question is one of the most important side effects to transmit an industry pace and to quickly adapt to the industry environment.

Q2. What problems and needs do you have related to the product design? This permits to spot and signal some key aspects that are slowing down the progress of the product development and/or the necessary resources to push the work flow.

It permits to improve research skills. The product development requires the use of skills to investigate and help develop these.

Q3. What tasks are you going to execute for the next week? This is also a critical question. Our CEOs let that each director defines every item to promise for execution for the following week. One director might start very conservative or protective with the offered compromises, but right away that director is pushed to be more aggressive either by measuring other directors´ promises or the own progress momentum of the product under development.

CEOs should definitely give a last touch of the weekly goals offered by each director. It is also important for the quality and progress of the project, but it is also critical for the cultivation of the industry culture. This question tries to help to increase the higher-order mental abilities, ant the capacity for analysis and synthesis, as well.

Q4. What is the current environment of your company? This question is presented to orient and support the management of the company. The teacher CEO gives mainly advises to directors on how to be successful to do a company meeting which starts as a difficult challenge, the value of convincing people instead of imposing, the secret of a pizza vis-à-vis a team work, etc. Teachers treat this information in a delicate way to solve every noise and to expose industry behavior.

4.2.2. The Weekly Report

The answers are written in a weekly report to the CEO, and discussed in the meeting thoroughly. The output of the meeting is the resulting task report for each company. Every answer is workout to the end to give a direct feedback to each company of their positioning among other companies, with respect to the product development, and specially an improvement on the company/people management, and the stirring of an entrepreneur spirit.

5. Upgrading the Methodology

The first results after completing in two term semesters this experience; we strongly feel that the work progress is vital to be supported by an online via. This is being programmed as an online course where companies will update their execution steps for each product, and teachers will continually orient upon problems and needs to support the progress of the project.

Using a teaching-learning environment based on web technology, like an online course allows the student has the opportunity to interact or communicate via the Internet, with content, with the teacher or facilitator and other course participants through various activities. In this particular case, the directors meeting and the weekly report as well as any other activity could be made throughout the online course.

Moreover, we are considering incorporating some web technological tools, such as *eGroupWare [8]*, which can be used to integrate learning strategies that allow simulating an industrial environment, in which the activities follow the policies and goals of an industry. *eGroupWare* is an application for works in groups via the Internet, which allows the management of relevant processes in a company such as group management and resources, planning and project development, cooperative work, documentation of processes, among others.

The WDM should maybe organized during a class scheduled hour, and be open to the whole class. We still believe that this meeting must be kept under the industry-like organization where directors are the principal ones to participate in the meeting, but companions are naturally admitted to support their directors around the discussion table.

Products might be used in a back to back manner thru the semesters to elevate their degree of implementation and/or complexity. This follow-up of projects should produce results closer to the commercial quality.

We are planning to build a track where real companies could place some projects to be taken under consideration for our school courses to develop. A funding agreement would equip the assigned class company to meet the offered challenge. We propose to integrate the social constructivism, implied in the workroom class, with the online learning and collaborative activities. The e-social constructivism will improve learning outcomes by designning, planning and teaching with collaborative e-learning activities. *[9]*

6. Conclusions

We have presented a new method to teach courses in an engineering program, specifically we have shown the experience in a class of “Introduction to Digital Programming I”. This form of education has been implemented in other courses of different level in the program and with a varied number of students.

We find that the process of designing a set of computer programs in the classroom, instead of focusing in the explanation of a sequential order of units, generates a richer, faster, and highly motivated teacher-student interaction.

We claim that a boiling environment of creativity and productivity appears as a natural result of multiplying an industry-like organization and rules-of-law for the class project development, like we found in our IPI course.

We have some positive results of class improvement in the percentage of students being promoted, around a 48% when in the past the number oscillated between a 6-15%. Today, after two periods of experienced, we are reaching the 68% mark. We expect to improve this number which is not yet satisfactory.

We have also created a number of simulators corresponding to a set of double-traffic lights in the city with all the routes estimating the time in traffic and its behaviors. As well as a solid level of learning among the successful students, specially the top class.

We find that the WDM is a strong tool to improve the industry-like acceptability and reproductively of the method. We feel now that this meeting should be located in the official scheduled hours. The WDM is a key factor that sets a solid difference between a project-based method and our industry-like method for the development of the product. In a one semester project-based method the product is not followed up by the teacher as in an industry environment by the leader. We claim here that the WDM offers this support in a very open manner, obtaining the valid expected results on time.

This industry set of policies has an immediate and positive impact on the motivation among students improving then, the quality and quantity academic goals. This method helps to develop competence; it helps to increase knowledge and ability in the discipline of content; it permits to improve research skills; it increase the higher-order mental abilities, capacity for analysis and synthesis; it promotes to take responsibility individually and collectively for the group company to successfully complete the product, among others.

This method has also shown the potential to support a more dynamic change of curricula for a course or program, by changing the products and/or class activities.

We conclude that an improvement in the overall academic activity within our System Engineering School is today present.

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