

ADVERTISE YOUR A/D CONVERTER, A SP TEACHING STRATEGY

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ABSTRACT

The goal of this paper is to invite the reader to consider role-playing as a method to train Signal Processing students for professional functions they would undertake in their future careers. Interaction, communication skills and learning purposes of SP concepts are key elements of this approach. An example applied to Analog to Digital converters is detailed, to show the advantages of this technique and the enthusiasm awakened.

Index Terms— Signal Processing Education, Educational technology, Analog-Digital Conversion, Sigma-Delta Modulation.

1. INTRODUCTION

Young EE students find it hard to concentrate in deep difficult subjects. This is not new, but nowadays high school years make it harder. I could realize that, from my experience over 20 years, the problem lies in the many ways communication has changed. Rapid stream of images, no chronological stories, instant messages, virtual relationships, short time effects, they all contribute to raise children not prepared to classical teaching methods.

Engineers consider themselves well equipped to deal with new challenges, so do engineering educators. We should gain knowledge of our new context and bring innovative ways to encourage students to digest their future profession. At the Electrical Engineering Department, I promote the application of nontraditional teaching methods, as long as they are proven constructive.

The intention of this paper is to give an example of such a procedure called role-play, applied to an undergraduate Signal Processing course.

2. LEARNING CONTEXT

In a five-year Electrical Engineering curriculum, the introductory Signal Processing course is located at the seventh semester. Students have a strong background in Mathematics and Physics, and already went to a Signal and

Systems course. They also had Analog Circuits laboratory classes and they are eager to start with DSP hardware.

We teach classical SP concepts, from DFT to Digital Filters, but we also pay strong attention in Analog to Digital interfaces. We want our students to be well prepared for both theory and practice.

Sampling methods and analog reconstruction filters are developed during the course. A/D and D/A Converter architectures are also studied. In order to enhance practical skills, students have to build an acquisition board, where the role of converters is well acquired.

Up to this point, the approach is quite classical. Some theory and some laboratory assignments were carried out to check important concepts and grow certain abilities. Results were positive [1], [2], but some education aspects were not addressed.

Students are going to initiate their professional's careers soon, where proper communication skills are mandatory.

3. ROLE-PLAY FUNDAMENTALS

In a role-play exercise, students assume the roles of characters in a given scenario. The scenario may be non fictional as the one depicted later on.

A role-play set-up should have sufficient elements to be challenging and engaging, it should have an underlying conflict, and it should be demanding to students' imagination.

Students' role in the scenario should be conventional, so that participants feel comfortable with their parts. To ease their apprehension, the scenario should offer opportunities for humor, so that the roles are amusing to play. No character should be totally good or bad, however [3].

Engineering Education is also a field where this technique has been applied with interesting results. Many articles report the successful application of role-play as a science and engineering teaching tool. For example, Bartz & Deaton [4] created a role-play of an industrial project team in a digital signal processing course.

In my classes, I do not intend to use this method in an extensive project, but for a short assignment. In this way, if

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performance is not good, consequences in students' grades will not be strong.

4. ASSIGNMENT GOALS

The purpose of a role-play assignment is to assess content understanding as well as professional skills development. I could find out that through the role-play scenarios, students learn:

- to make authentic use of recent acquired knowledge in the area
- to understand multiple perspectives in professional life
- to perceive some moral issues in the conduct of an engineer
- to negotiate practical solutions to unexpected problems beyond academic life

The organization in class to achieve these goals should be prepared carefully. After eight weeks from the beginning of the course, and having explained all subjects involved, students are arranged in teams of four to five members. In each one, it is advisable to have at least three kinds of individualities: an unquestionable leader, someone with bold personality and a proficient student.

The scenario is a Developer Training Event, organized by "the Company" where the character has a job as technologist in Analog to Digital Converters. The venue is well known in the signal processing industry, and brings together a big number of experts in development, design and research as well as engineering executives. Some competitors from "the Company" will be present to point out deficiencies of the product.

The professor will act both, as moderator and as an expert in development with an executive role.

Before the scenario's launch, he has to explain the role-play exercise and describe approaches to the activity that will maximize the benefits to the students' grades. Once the scenario is rolling, he has to facilitate each character performance and also ask key role-play questions.

The first team will play the role of technologists, letting the developers' characters to the rest of students. They have to wear "Company" logos on their shirts. Each member, who must have a speaking role, will receive instructions for his character. They should act out their roles as realistically as possible. This kind of role-play is based on the jigsaw method [5].

During class, sufficient time should be available for each group to be in front of the others, so that students can change roles between situations and thus learn the perspectives of different parties. I found that the two role-plays often run differently and highlight different issues.

They begin by introducing their characters, and a short overview of their presentation, which has to last ten minutes. After that, they explain technical specifications of

his product, the benefits of its use in developing a certain application, characteristics that outperform those of competitors, and selling prices and conditions.

Next, during five minutes, "competitors" will pose compromising questions.

During the presentation the professor/moderator will build an outline of questionable points that will be asked at the end of the show, when they contribute to the assignment goals.

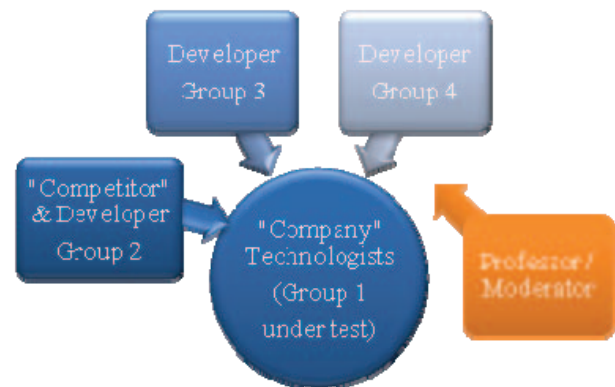


Figure 1. Proposed scenario layout

I used the allocation of student in the classroom, as it is shown in Figure 1, to facilitate expected roles.

If that is the case, students who are reluctant to assume speaking roles may serve as observers for a role-playing team. It is not the ideal situation, because it is expected to promote student oral skills during the exercise [6].

Observers have to take notes as the scenario is played out. Each observer (no more than one per group) will have a guide to assess how well each participant conveyed the character's position, what points were missed by each speaker, where the interaction may have taken a turn for better or worse, and other factors relevant to the learning strategy. If it happens to be that there is not an observer available, the professor will assume such a role.

5. SP CONCEPTS INVOLVED

Converts classes prior to the role-play project consist on lectures about Analog to Digital (ADC) and Digital to Analog (DAC) architectures and key performance specifications [7].

A list of concepts developed is illustrated to grasp the material that students should manage during the assignment. Easier to introduce, there are several architectures for DAC chips included in the course:

- Resistive ladder network (R2R)
- String of resistors
- Current steering
- Sigma-delta [8]

In the case of ADCs, studied architectures are:

- Double Ramp
- Flash
- Pipeline
- SAR (Successive-Approximations Register)
- Sigma-Delta [8]

It is also important to point out performance specifications explained in class:

- Resolution
- Sample Rate
- SNR (Signal-to-noise ratio)
- DNL (Differential Nonlinearity) error
- INL (Integer Nonlinearity error)
- SINAD (Signal-to-noise and distortion ratio)
- SFDR (Spurious Free Dynamic Range)
- Power Dissipation
- Input Voltage Range
- Noise Immunity

The overflow of ADCs makes it difficult to know which one best fits a given application. All too often when engineers select ADCs, they simply look at bits, signal-to-noise ratio and trade-off costs. But other specifications have equal importance, opening an interesting problem to developers and manufacturer technologists.

That is where my role-play exercise had an underlying conflict and a technical challenge at the same time.

6. METHODOLOGY

Each student group (no more than six) is assigned an ADC from a certain manufacturer. I always arrange them in even numbers, in order to have team pairs with similar converters from different firms (future “competitor” or opponent).

Looking at the allocated manufacturer's ADC data sheet, and researching other sources of information, students must prepare their presentation within a week, including the following requirements:

- ADC Key performance features.
- ADC architecture, suitable for a chosen application.
- ADC parameter values, presented at the convenience of the company (a selling strategy showing why this ADC is better than its competitors).
- General applications and some specific example, intended to make the product excel.
- A complementary DAC recommended for a full interface.
- Actual market price in Argentina compared to the competition.
- Official guarantee and technical support specifically suited for our country.

Along with the oral presentation, students should hand out some promotional material addressed to developers. Fun is also part of the task.

7. ASSESMENT METRICS

For the role-play class both students and professor have to be well focused. Timing, student attention and assessment strategy should be carefully addressed.

To determine whether this role-play scenario achieves desired outcomes, the evaluator must assess its effectiveness.

Therefore, groups' performance is evaluated in each of the following angles:

- Contents effective learning*: Professor should take into account how well converter concepts are applied during the presentation
- Oral skills*: Individual and group efforts to act each role have to be assessed.
- Negotiation competence*: It analyzes the ability of any student to overcome difficult questions and situations posed by “competitors”.
- Different perspective gained*: This assessment takes into consideration the standpoint of the “developers” posing relevant questions.
- Handling of moral issues*: Sometimes, hiding bad specifications or remarking other manufacturer failures could cause an ethic problem. Professor should comment these situations and propose solutions. Students should know how this issue is graded.

It is clear that each approach has different relevance at this point of the engineering curriculum.

There are also two grades obtained; a group score and an individual mark. The average of both performances is the final grade.

Table 1 shows how the evaluation for each student is built.

	a	b	c	d	e
team	60%	30%	-	-	10%
indiv.	30%	10%	20%	40%	-

Table 1. Grade structure

When a student could not be evaluated in some of the above categories, content (a) should carry the missing part.

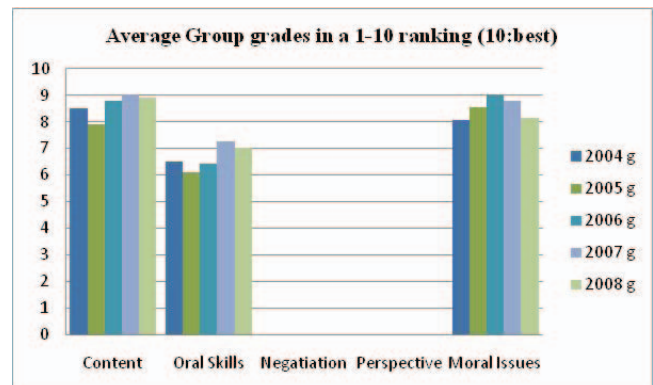


Figure 2. Group grades between 2004 and 2008

In the last five years, results have been motivating, as average grade charts illustrate.

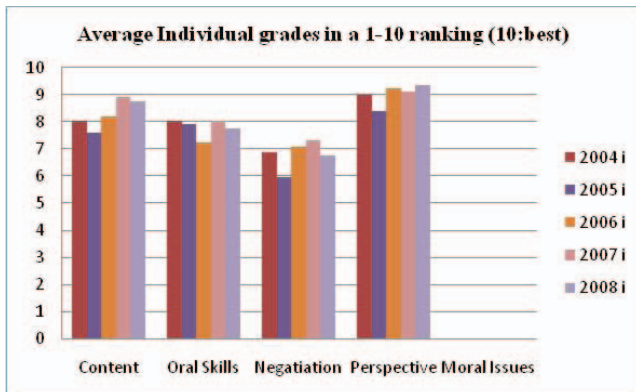


Figure 3. Individual grades between 2004 and 2008

From the figures we can extract interesting topics. Figures 2 and 3 confirm that contents are almost always well acquired, given that individual difficult cases are scarce to affect averages. Group oral skills are the weakest point, but it is encouraging to have them addressed. In the case of “competitors” posing questions (individual oral skills), they performed well. Negotiation is a hard topic, but they manage to overcome the challenge. Perspective gain and moral issues give very nice results, which represent a certain advantage of the role-play method.

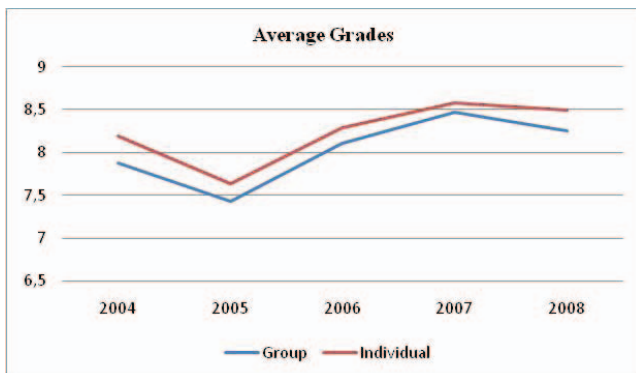


Figure 4. Average grades between 2004 and 2008

We can also infer from figure 4 that cohorts may have different performance, but the average group and individual grades are correlated. I find it as a positive team work. Student surveys about course performance never showed negative feedback about this assignment, they even suggested us to use role-play more often. I have used a quantitative and qualitative method to carefully assess the effectiveness of role-play in achieving assorted learning objectives in SP education, that demands extra effort from the professor point of view. But it is

worthwhile, because students like the idea of being engineers for one day, improving their encouragement to work harder.

8. CONCLUSIONS

During the last five years, it was confirmed that role-play assignment is an alternative education tool that can enhance student learning experience according to today's teaching challenges. Its evaluation criterion works well within certain subjects in engineering, and could be used to enhance teaching style and quality.

An example related to Analog to Digital and Digital to Analog Converters theory was explained.

From a carefully plan scenario, it is feasible to obtain high student grades, which not only evaluate course content but also other distinctive abilities. I could include in the grade criteria oral skills, negotiation competence, different professional perspectives, and how to handle some moral issues.

I believe that role-play is an effective teaching tool because it engages students both personally and actively. During the activity, it requires creative solution of problems, and it promotes empathy with the perspectives of different parties.

9. REFERENCES

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