Work in Progress - Image Processing (and CATs) as an Introduction to Algorithmic Thinking

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Abstract – An Engineering Workshop is mandatory en the third term of the engineering curricula of a sister institution. In the workshop each major choice is allowed to have a four week introductory mini course. We were asked to develop such a course for Computer Science majors. In order to give our students an early taste of programming and helping the other students with their academic skills, we chose to develop algorithmic thinking contextualized as Image Processing.

In the paper we describe the choices we made and how we used Classroom Assessment Techniques (CATs) to enhance the students experience. We explain how we structured the full course and the grading around the CATs. The course was graded using a performance evaluation over a team project: the enhancement or restoration of an image chosen by the team, with a program also chosen by the team, accompanied with a documented solution of the problem.

Index Terms – Classroom Assessment techniques, Algorithmic Thinking, Contextualized Courses, CS Introduction.

INTRODUCTION

It is usual in Argentinean Universities that students of different field disciplines (majors) share the first three terms subjects. To help students to choose their major, a sister institution implemented an Engineering Workshop. Instead of focusing the workshop in general engineering practice such as design, they decided to split in four different 4-weeks sections. Each section developed tasks related to a field discipline with the goal of helping student to understand how it is like to work in such a discipline. The offer spreads to all the majors offered, but students must choose four sections.

We were asked to develop a pilot four-week course as an introduction to Informatics Engineering, which can be defined as some mix of Software Engineering and Computer Science according to the IEEE-ACM curriculum. It is not uncommon that students who chose Informatics considered Calculus, Physics and Chemistry as a hurdle more than an enabling knowledge. Trying to address this preconception and to prepare students for algorithmic thinking we developed a four weeks course on Image Processing without the usual heavy mathematical baggage.

Aimed at a broader audience than classical CS1 courses, we elaborated our teaching plan stressing the development of basic academic success and high order thinking skills. We used a set of Classroom Assessment tools [4] chosen according to Angelo and Cross's Teaching Goals Inventory [5].

We hoped to give our students a first taste on algorithmics and Informatics without involving then in the nuisances of a full programming environment and using motivating activities.

IMAGE PROCESSING

The Computing Curricula includes Image Processing only in their Computer Engineering course recommendation [6], in a Signal and System Context. It is not in the core recommendation but is an elective after developing the necessary background. It is not present in the Computer Science Curriculum [7].

However, there are reports on using Image Processing as a contextualized course in both, CS1 and CS2 [8]. Having only four meetings we decided to use an exploring Lab format, with some practical demonstration first followed by students hands on work.

The topics we chose for the demonstrations were:
- Definition of a digital image; digital images as matrices, types of images (binary, greyscale, colored, indexed).
- Lossy and looseless image compression and file formats.
- Point operations and histogram processing: brightness, contrast, thresholding.

ALGORITHMIC THINKING

In a classical work, Donald Knuth [1] stated that Algorithmic thinking makes heavy use of different “reasoning modes” (in Knuth's terms) and described then as: Formula Manipulation, Representation of Reality, Reduction to simpler Problems, Abstract reasoning, Building Information Structures and the obvious Building rules on how to solve problems (Algorithms). Also there is some claims of algorithmic thinking as a bridge from Descriptive Sciences and Humanities to Math [2]. Undoubtedly every first class of CS1 or CS Introductions contains some sort of exercise in Algorithmic thinking before jumping into programming. Some of these introductions are really creative, fun and enlightening for the students [3].

From data collected in the previous courses we found that students who chose Informatics considered Calculus, Physics and Chemistry as a hurdle more than an enabling knowledge. Trying to address this preconception and to prepare students for algorithmic thinking we developed a four weeks course on Image Processing without the usual heavy mathematical baggage.

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A panoramic lecture showing several neighborhood operations such as edge enhancement, embossing and blurring.

We chose Fiji [9] as the Image Processing Program. It is a free multiplatform program written in Java, a package based on the ImageJ API, used in Biology, Astronomy and several other areas.

The meetings were graded using a performance evaluation over a team project: the enhancement or restoration of an image chosen by the team, with a program also chosen by the team, accompanied with a documented solution of the problem.

CLASSROOM ASSESSMENT TOOLS (CATS)

Through close observation of students in the process of learning, the collection of frequent feedback on students' learning, and the design of modest classroom experiments, teachers can learn much about how students learn and, more specifically, how students respond to particular teaching approaches.

Classroom Assessment is a learner centered tool that focuses the primary attention of teachers and students on observing and improving learning, rather than on observing and improving teaching. CATs are designed to evaluate student attitudes, values, and self-awareness, reactions to instruction methods and course-related knowledge and skills including prior knowledge, recall and understanding; analysis and critical thinking skills; synthesis and creative thinking skills; problem solving skills; and application and performance skills [4].

THE COURSE AND THE CATS

From the result of our Teaching Goals Inventory we choose three CATs for use during the meetings:

Defining Features Matrix: is a simple CAT, easy to realize and helps to categorize important information. After lecturing several related concepts, the class was asked to categorize concepts according to the presence or absence of important defining features. After some time of working alone, working in groups was enabled and a discussion of the results followed.

This CAT was used after the meetings where definitions were presented. In the meetings where procedures were explained, students followed the procedures in their own computers. At the end they have to complete two complementary CATs.

One Sentence Summary: the class was asked to summarize a large amount of information in one sentence that answers the questions, "Who does what to whom, when, where, how and why?" This CAT was very useful for helping students in focusing on the material presented in the course.

Muddiest Point: students were asked to point the muddiest point of the presented material.

After the meetings, to pass the course and for grading purposes we choose another CAT.

Documented Problem Solution: teams were asked to keep track of the steps they take in solving a problem of image restoration or enhancing and to tell how they worked it out.

Teams had to present the chosen image before and after processing, to summarize the used image processing program features, and a step by step solution guide. In interviews one of us blindly followed the steps in front of the students giving them a feeling of how their instructions were understood. Teams are allowed to correct the document and have a second grading opportunity.

When teams presented their work, an interview is held individually where we try to state if

- it was the first time they had to write instruction to accomplish a difficult task,
- Math and Physic related material were recognized in the Image Processing Lab,
- they really understood what the Image processing program was doing in each step.

CONCLUDING REMARKS

Other sections of the same workshop used other contexts to develop their material. Html programming, spreadsheets and modding (personalizing computer chassis) were some of the chosen contexts. The institution did not provide other means to assess the success than the number of students who changed their major after having the workshop. These figures are not yet available.

All of the teams so far had to come back for a second presentation. It was an expected result because writing skills are not addressed until the later courses in all the curricula.

We found a lot of math related terms in their presentations. Interviews showed an increased awareness of the importance of math in their profession. This was not the case for Physics because the short time allotted did not allow us to enter in issues like color and perception.

Some students used programs with task oriented interfaces such as Picasa or iPhoto instead of engineering oriented interfaces as with Fiji, Gimp and Photoshop. Finally these students were able to develop clear instructions on how to reproduce their result, but failed to understand the underlying operations. It was a chance of speaking with them about the difference of using and developing a tool. This is a key concept usually misunderstood when students chose their career.

The one sentences summaries and muddiest point reports helped a lot in understanding the language, background and attitudes of the classroom. And to develop ways of deploying the course material in line with these characteristics, for example, using slides with Internet links for in deep reading.

All students reported to enjoy the experience, even students not pursuing Informatics or EE. Digital photography is part of they everyday life and the meetings gave them a technological insight about it.

978-1-4244-6262-9/10/$26.00 ©2010 IEEE
October 27 - 30, 2010, Washington, DC
40th ASEE/IEEE Frontiers in Education Conference
REFERENCES


