Teaching/Learning a First Object-Oriented Programming Course outside the CS Curriculum

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http://cupi2.uniandes.edu.co
Agenda

- Context
- Main issues
- 7 thematic Axes
- Proposal
- Results and Conclusions
- Questions
Context

- The University of Los Andes offers a first course in computer programming to freshmen of several and diverse programs.
- There are challenges that we have to face due to the number of students (900 students each semester) as well as to the difficulty of teaching/learning how to program.
- A failure rate around 30%.
- A satisfaction about the course less than 70%.
Main issues

- Motivational aspects and frustration
- Methodological problems in teaching/learning programming (Learning by Imitation)
- Bottom-up approach
- Lack of balance in the aspects related to building a program that solves a problem.
Main issues

- Motivational aspects and frustration

“Programming is difficult”
Main issues

- Motivational aspects and frustration

“Programming is boring”
Main issues

- Motivational aspects and frustration

There is a big gap between the board and the computer” (or “everything works on the board”)
Main issues

- Motivational aspects and frustration

“The exercises are too plain for the effort”
Main issues

- Motivational aspects and frustration

“Can we do something funnier?”
Main issues

- Motivational aspects and frustration

“At the end, if it works, it's because “something” magical happened”
Main issues

- Methodological problems in teaching/learning programming
  - Learning by Imitation:
    - IF instructor writes a solution in the board THEN students write a similar solution for a similar problem

“In fact, the day of the exam, I must have the inspiration”
Main issues

- **Bottom-up approach**
  - First: variables, data types, expressions
  - Then: conditional instructions,
  - Then: iterative instructions, class, object, method,
  - ...
  - By the end of the term, they can develop only simple and uninteresting exercises to practice the algorithmic
Main issues

- Lack of balance in the aspects related to building a program that solves a problem
  - Most of the times the course is based on the algorithmic aspects or on the programming languages
  - Does anything else matter?
7 Thematic Axes

- Software Process
- Modeling and problem solution
- Algorithmic
- Methodologies
- Architecture
- Programming
- Programming tools

knowledge abilities
Agenda

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- 7 thematic Axes
- Proposal
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Proposal

Our approach

- active learning
- incremental generation of abilities
- problem-oriented
- balance of thematic axes

current technology

- Java
- UML
- Eclipse
- Objects

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Thematic Axes and Levels

Axis 1 - Modeling and problem solution
Axis 2 - Algorithmic programming
Axis 3 - Tools
Axis 4 - Software process
Axis 5 - Architecture
Axis 6 - Methodologies
Axis 7 - Methodologies

Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
## Thematic Axes and Levels

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Small applications
A small application

This is an example of a statement of needs. This is an example of a statement of needs. This is an example of a statement of needs.

Gui requirements

Conceptual class diagram

Description

Functional requirements

<table>
<thead>
<tr>
<th>Nombre</th>
<th>R1 – Crear una tarjeta TARCINE para un cliente</th>
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</thead>
<tbody>
<tr>
<td>Resumen</td>
<td>Se crea una tarjeta para el cliente identificado con una cédula dada. La tarjeta se debe crear con un monto o carga inicial de $70.000. Si el usuario ya tiene una tarjeta registrada, no se puede crear y se presenta un mensaje de error.</td>
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<tr>
<td>Entradas</td>
<td>La cédula del cliente</td>
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<tr>
<td>Resultados</td>
<td>Una tarjeta se ha creado para el cliente indicado. La tarjeta tiene una carga inicial de $70.000. Si el cliente ya tiene registrada una tarjeta, no se crea y se presenta un mensaje explicativo.</td>
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</table>
A small application (2)

Package structure

uniandes.cupi2.cine.gui
uniandes.cupi2.cine.kernel
uniandes.cupi2.cine.test

Files structure

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A small application

It runs

I can change the code and then execute the unit tests

I can read the javadoc

I have the documentation and it's updated

eclipse

Some elements are **given** as input, others should be either **completed** or **developed**
Level 1
Problems, Solutions and Programs

- Class, objects, methods, attributes
- Basic abilities of analysis
- Basic structure of a program
- Some simple data types
- Some operators
- Assignment
- Method invocation
- Introduction to java and Eclipse
- UML class diagrams
Level 2
Defining conditions and managing cases

- Logic expressions, relational operators, logic operators,
- Conditional instructions
- Usage of constants
- Assigning responsibilities
- Constructors, getters and setters
- Concept of variable
- Methods and parameters
Level 3
Managing groups of attributes

- Aggregation of fixed and variable size
- Iterative instructions (for, while)
- Idioms to traverse aggregation using cycles
- UML aggregation
- Generation and usage of Javadoc

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Level 4

Defining and Assuming responsibilities

- Contracts, precondition y post condition
- Exceptions
- Some techniques to assign responsibilities
- Javadoc to specify a contract
- try-catch, throw
- “Divide and conquer” applied to functional requirements
Level 5
Building a graphical user interface

- GUI architecture
- Frames, panels, labels, layouts, buttons, events, …
- Assignment of responsibilities
- Java Swing Framework
- main() method
Level 6
Two dimension structures and persistence

- Two dimensional structures (matrixes)
- Basic persistence to store the initial state of the application (Properties)
- A first complete application
## Thematic Axes and Levels

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Small applications
Training Tools
Training Tools
Training Tools

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Support materials

Virtual Learning community

workbook

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Each instructor has a space in the virtual community
They share materials, comments, exams, labs, hands-on, etc.
## Results

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<tbody>
<tr>
<td>Instructor Evaluation</td>
<td>83%</td>
<td>82%</td>
<td>84%</td>
<td>87%</td>
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<tr>
<td>Course Evaluation</td>
<td>74%</td>
<td>70%</td>
<td>74%</td>
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<tr>
<td>Failure Rate</td>
<td>28%</td>
<td>30%</td>
<td>26%</td>
<td>16%</td>
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<tr>
<td>Average Grade</td>
<td>3.32</td>
<td>3.36</td>
<td>3.41</td>
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Results

Course Evaluation

- New Course
- Old Course

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Results

Failure Rate

- New Course
- Old Course

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<th></th>
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<tbody>
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Conclusions

- Approach:
  - Balance between different axes
  - Active learning: based on problems, incremental generation of abilities
- So far, the indicators are positives
- All project products are public
- Other universities will use the project next semester