Getting CS Undergraduates to Communicate Effectively

Andreas Karatsolis, Iliano Cervesato, Nael Abu-Ghazaleh, Yonina Cooper, Khaled Harras, Kemal Oflazer, Thierry Sans

Carnegie Mellon University – Qatar campus
A Real World Story

From Begel, Simon (2008): *Novice Software developers, all over again*
Skill Set for Graduating CS Students

1. Ability to analyze the complexity and correctness of algorithms and data structures
2. Ability to select an appropriate algorithm for a given problem
3. Necessary mathematical skills to solve problems
4. Recognize the limits of computation when applied to specific problems
5. Ability to evaluate and assess the appropriateness of a programming language for a particular problem
6. Ability to implement solutions to algorithmic problems (in a variety of programming languages)
7. Ability to develop effective solutions to computing system problems
8. Ability to perform critical technical analysis of computer systems
9. Ability to build large systems-based projects (e.g., operating systems, networking, databases)
10. Ability to use different tools for software development and debugging
11. Ability to do tradeoff analysis between competing solution designs
12. Ability to inspect and test code
13. Ability to adapt and apply computing fundamentals to new/emerging technologies

14. Effective presentation skills
15. Effective written communication skills

16. Ability to set goals and a plan to achieve them
17. Skills to effectively work in teams
18. Ability to manage time and meet deadlines
19. Ability to identify risks involved in a given situation
20. Ability to discover and articulate individual, organizational and societal needs and to design and implement appropriate solutions
21. Ability to foresee the outcome of unethical behavior on one’s career and on surrounding society

Based on IEEE/ACM Computing Curricula 2001
Developing Mastery

Students need to

- acquire component skills
- practice integrating them
- know when to apply what they have learned

How to Teach Mastery?

1. Acquire fundamentals – technical skills
   - Style (e.g. nominalization, parallelism, given-new)
   - Document/Visual Design (e.g. chunking, alignment)
   - Management and Production skills (e.g. styling)

2. Integration of skills in simulation mode

3. Application in concrete situations, within actual professional context
How Mastery is Taught

Common approach

- Practicing technical skills
- Simulating practice
- Performing in real contexts

Right now at CMU-Q

- Practicing technical skills
- Simulating practice
- Performing in real contexts
Case Study

15-221
Technical Writing for CS
## Step 1: Practicing Basic Skills

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Component Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV and Cover Letter</td>
<td>Alignment and Contrast, Proximity and Repetition, Correctness</td>
</tr>
<tr>
<td>Genre Analysis</td>
<td>Emphasis and Framing, Gapping (captions and headings), Data commentary moves</td>
</tr>
<tr>
<td>Proposal</td>
<td>Nominalizations, Coherence (global and local), Forecasting and summarizing (metadiscourse)</td>
</tr>
</tbody>
</table>
Step 1: Proposal Writing Assignment

What are the components?

- Establish the situation by telling a good story
  - Nominalizations
- Use objectives to frame the methodology section
  - Coherence
- Describe the benefits at the end of opening section
  - Forecasting/summarizing
Step 2: Integrating Skills in Simulation

• Integration of existing skills is itself a skill
  ▪ Needs to be practiced to be mastered
    ▪ E.g. presenting

• Constrain task
  ▪ Assign initial problems with fewer components/degrees of freedom to gradually build up to multiple components
Introduction

The Qatar National Science Agency (QNSA) solicits proposals for the first round of the Qatar Technology Initiative Program (QTIP). Recognizing the potential impact of the World Wide Web (WWW), Qatar is seeking to position itself both to improve the quality of life for its citizens, region and the world, as well as to help diversify its hydrocarbons based economy to a knowledge based one. The WWW is a revolutionary new medium that promises to interconnecting humans and sharing knowledge never before possible. The WWW will have a profound impact on how we live our lives in the 2000s and beyond.

Deliverables

- Draft proposal with peer review workshop
- Group presentations and panel review
- Final written proposal
- Elevator pitch
- Powerpoint presentation
Step 3: Applied Projects

• Work with *real* clients (internal or external) to support their documentation needs

• Deliverables
  ▪ Draft with rationale for choice of medium
  ▪ Oral presentation
  ▪ User testing report
  ▪ Client memo
  ▪ Final version of documentation artifact
  ▪ Group meeting minutes and individual logs
Project 1: Abridged User Guide

Client: MADA – Center for Assistive Technologies

- Device to “read” book in Braille
  - Original manual was a 700 page paper book

- Wrote a 6 page version
  - Print and Braille

![Image of Book Sense Daisy Book Player](image)
Project 2: Screen Reader

Client: MADA

Cell phone app for visually impaired
  - Zooms or reads SMS and menus

- Developed manual
  - Extended it with in-phone voice search of manual topics
All three steps in summary

Helping students acquire component skills involves
- First, identifying component skills students need
- Then, offering students sufficient practice on these skills

Helping students learn to integrate skills involves
- First, recognizing where multiple skills may overlap
- Then, focusing students on the goal of integration

Helping students apply and transfer what they learn
- First, appreciating the inherent difficulty of transfer
- Then, promoting transfer and application by helping students work within different conditions and contexts
Case Study

15-129

CS Immigration
Expose freshmen to the world of Computer Science

- Help them integrate with the CMU culture

- Four general components/requirements
  - Attend 7 CS talks given by field experts
  - Student presentations on other CS areas
  - Webpage setup and design, with all work conducted uploaded there on time
  - Extra points by volunteering for other activities
15-129: Observations

- During expert talks
  
  **Problem:** Students don’t know what OS, SE, Networking, AI...etc. are
  
  - Shy to ask, and can be disconnected
  
  **Solution:** Encourage exploring the area before listening to talk by requesting that they
  
  - research area
  - summarize/paraphrase, insert links
  - 3-5 questions they have
  - upload all this on their webpage

- Exposed their "natural" form of writing
  
  - shed light on the more basic capabilities
Case Study

15-502
Technology and Global Development
15-502: Course Objectives

• Introduce students to field of Technology for Developing Communities
  ▪ Enhance students’ writing and presentation skills

• Writing components
  1. Research a proposal project
  2. Design and implement plan to promote project
  3. Plan capacity building for project
  4. Critically read and analyze a case study

Initially projects were simulated scenarios, later actual internship projects for the following summer
15-502: Observations

• General
  ▪ Extensive help needed reading assignments
  ▪ Extensive help needed addressing requirements

• Simulated practice (fictitious scenarios)
  ▪ Students not overly motivated
  ▪ Numerous complaints to instructors

• Real-life project (summer internship)
  ▪ Students were motivated and interested
  ▪ Accepted feedback and strived to improve
Future Work

• Communication across the curriculum
  ▪ Design a more intensional approach
    ▪ Coordinate courses
    ▪ Involve more instructors
• OLI module that addresses all these component skills
Thank you!

Questions?