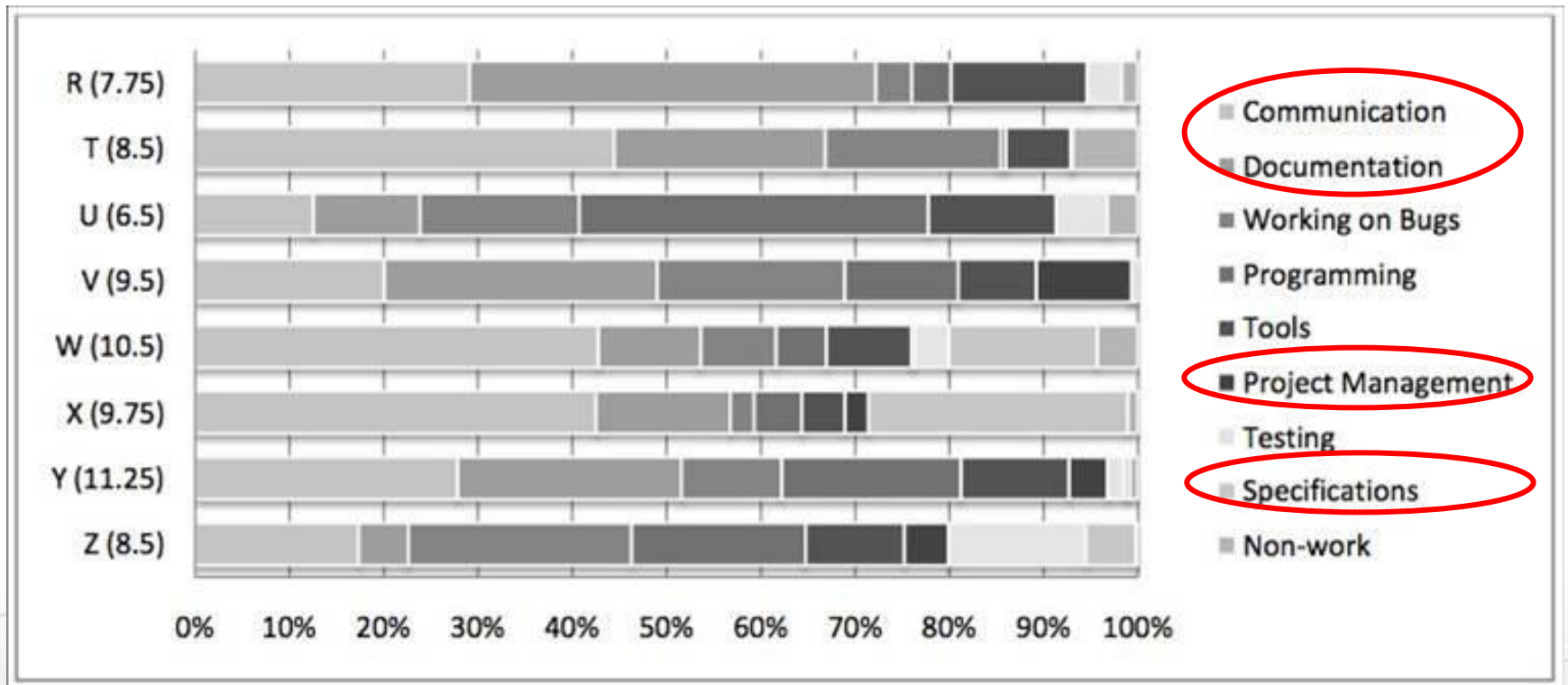# Getting CS Undergraduates to Communicate Effectively

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

Carnegie Mellon University – Qatar campus

جامعة كارنيجي ميلون في قطر
Carnegie Mellon Qatar

A **R**eal **W**orld 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
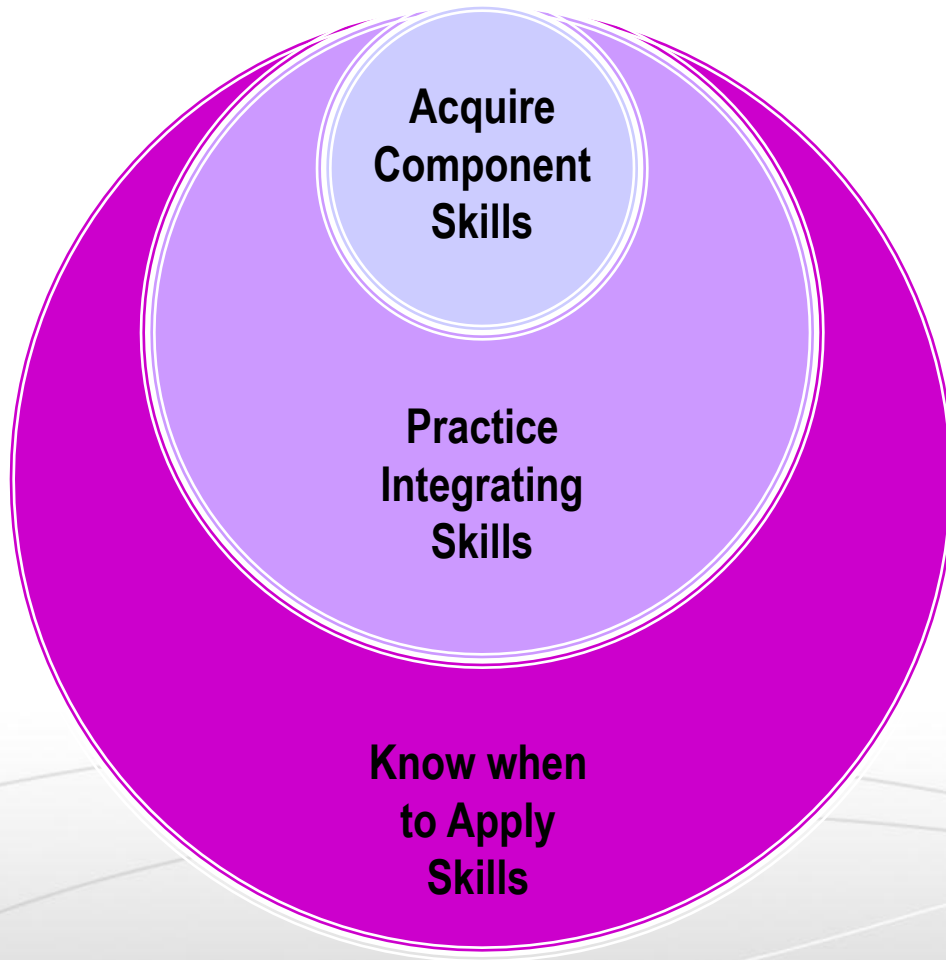13. Ability to adapt and apply computing fundamentals to new/emerging technologies

14. Effective presentation skills

15. Effective written communication skills

16. Ability to set goals and plan to achieve them
17. Skill to effectively work in teams
18. Ability to manage time and work with deadlines
19. Ability to identify tasks 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
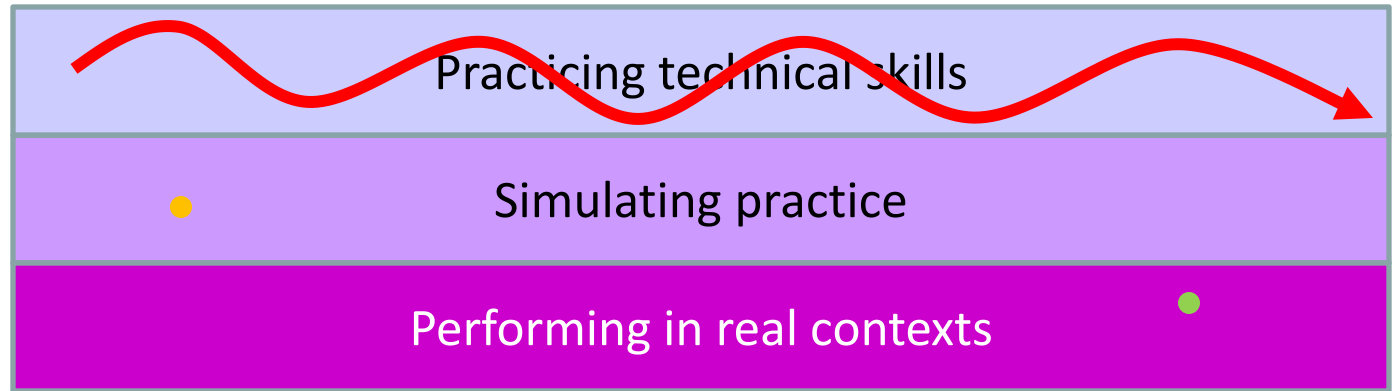
Based on *IEEE/ACM Computing Curricula 2001*

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Developing Mastery

Acquire Component Skills

Practice Integrating Skills

Know when to Apply Skills

Students need to

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

From Ambrose, Bridges, DiPietro, Lovett, Norman (2010).
How Learning Works: 7 Research-Based Principles for Smart Teaching.

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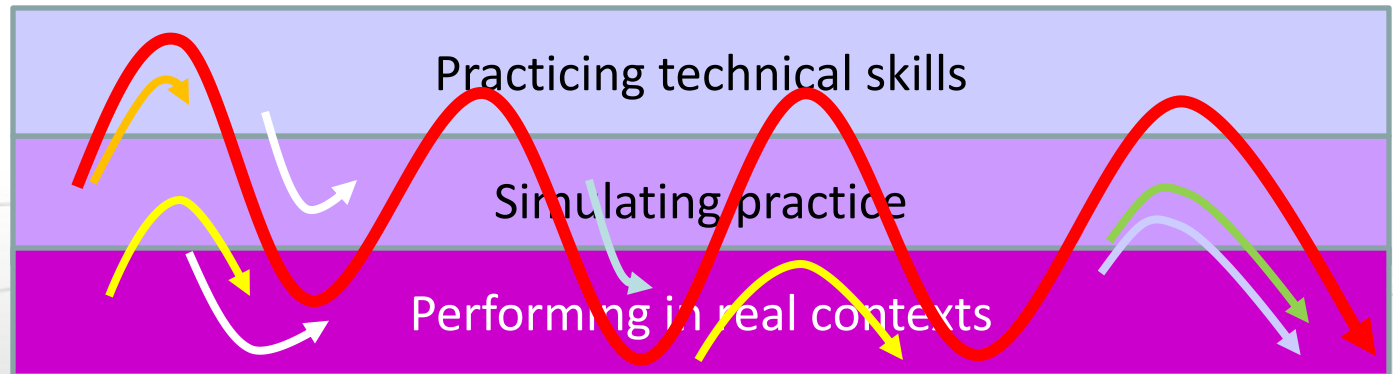
How to Teach Mastery?

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

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Participating Courses
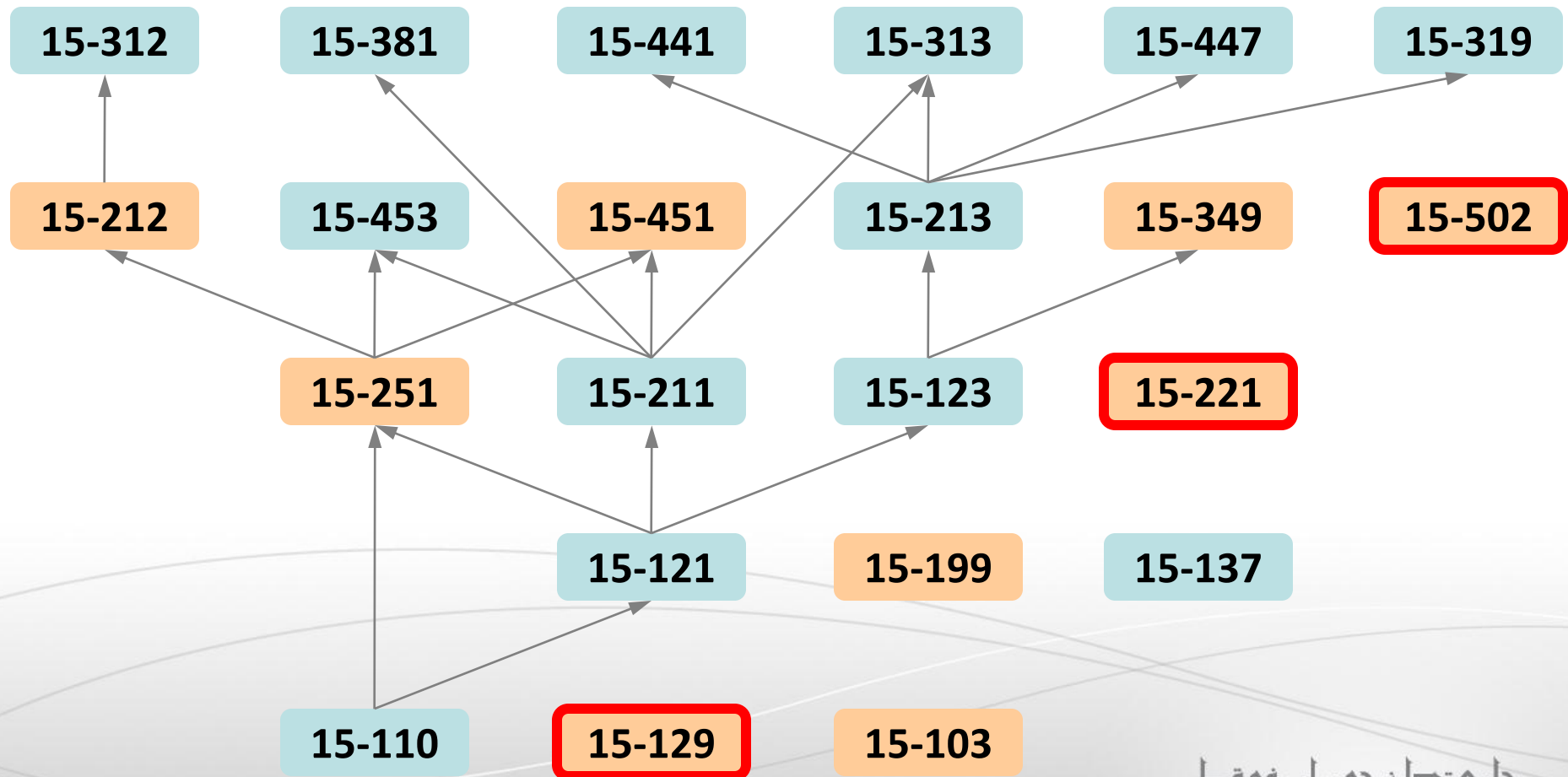
Case Study

15-221

Technical Writing for CS

Step 1: Practicing Basic Skills

Assignment	Component Skills
CV and Cover Letter	Alignment and Contrast
	Proximity and Repetition
	Correctness
Genre Analysis	Emphasis and Framing
	Gapping (captions and headings)
	Data commentary moves
User Manual	Concision
	Procedural/functional elaboration
	Given-new contract
	Length of sentences and paragraphs
Proposal	Nominalizations
	Coherence (global and local)
	Forecasting and summarizing (metadiscourse)

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

Step 2: Proposal Writing Assignment

Qatar National Science Agency

Request for Proposals 30/10/1996

Introduction

The Qatar National Science Agency (QNSA) solicits proposals for the first round of the Qatar Techno (QTIP). Recognizing the potential impac (WWW), Qatar is seeking to position its both to improve the quality of life for its region and the world, as well as to help d hydrocarbons based economy to a kno WWW is a revolutionary new medium interconnecting humans and sharing kn never before possible. The WWW will h how we live our lives in the 2000s and bey

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

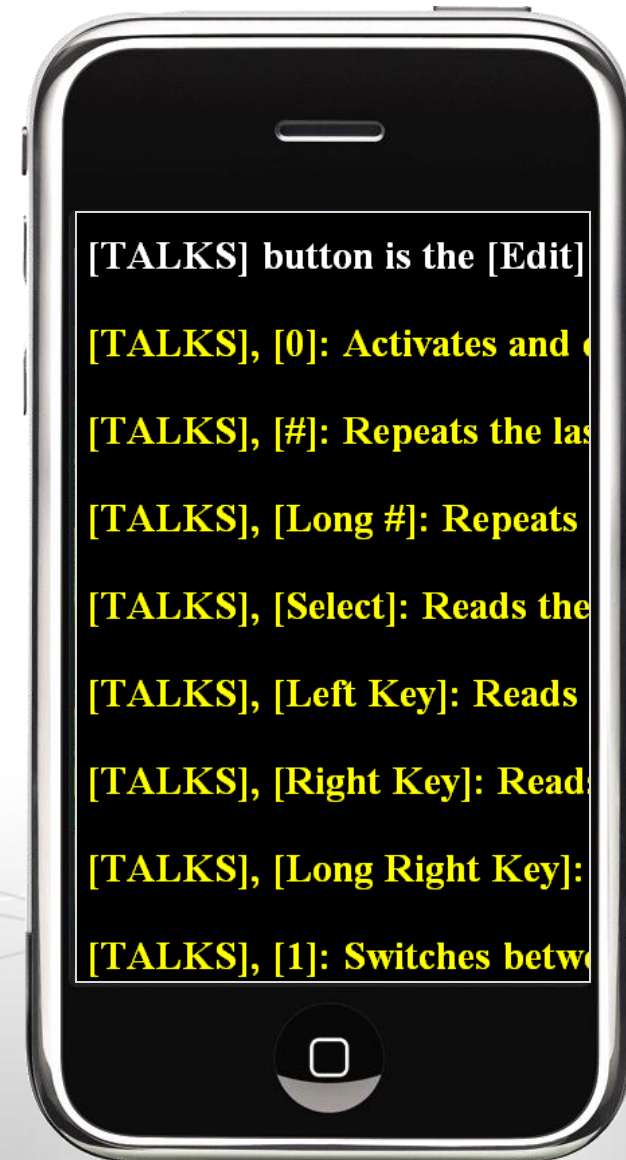Book Sense Daisy Book Player
Quick Start Guide

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

[TALKS] button is the [Edit]

[TALKS], [0]: Activates and

[TALKS], [#]: Repeats the las

[TALKS], [Long #]: Repeats

[TALKS], [Select]: Reads the

[TALKS], [Left Key]: Reads

[TALKS], [Right Key]: Read

[TALKS], [Long Right Key]:

[TALKS], [1]: Switches betw

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

15-129: Course Objectives

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

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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?