Supporting Active Learning through Interactive Content and Learning Analytics

Learning Track: Leveraging Technology
Giving Ownership of Active Learning to Students in Computer Science
(GOALS in CS)
Project Overview

- Partnership between CSU and CC
- Focus on introductory sequence
- Interactive online course content
- Flipped classroom format
The Problem

College introductory CS curriculum typically focuses on how computers interpret instructions and relies on unduly difficult, abstract mathematical models.

Traditional lecture-heavy structure of college CS courses is in stark contrast to successful CS interventions in high school, lacking both real-world problems and the opportunities for students to use prior knowledge and background.

Often do not utilize community-building pedagogy, which is a successful strategy to engage women and underrepresented minorities.
Local Impact

Self Reflection – similar curricular approach at CSUSM & MCC
Examine Institutional Data
Higher than average drop, fail, or withdrawal (DWF) rates than our institutional averages.
Ownership of Learning

Support

Respect

Life experiences

Passions
The Open Learning Initiative (OLI) Platform

- Created by Carnegie Mellon University
- A Learning Engineering approach to instructional design and research
Many years ago, the word "computer" was defined in the dictionaries as a person who computes. The movie *Hidden Figures* tells the story of three African American women who were hired by NASA as *human computers*: Katherine Johnson, Dorothy Vaughan, and Mary Jackson. The first few

```
class ADT_name {
private:
  data_type data_member1;
  data_type data_member2;
  ...
public:
  member_function_prototyped1;
  member_function_prototyped1;
  ...
}; //note the semicolon
```

**Watch the following video** to hear from Facebook engineers of a diverse background talking about what computer science mean to them and why they think it is important to have a diverse workforce in computing fields.

What is Computer Science - TechPrep by Facebook

**My Response...**

What did the engineers say about Computer Science that resonate with you most?
Given the above code, drag the elements to their corresponding targets.

```
string greeting = "Hello World!";
int index = greeting.find("o", 5);
```

Given the following two Clock objects:

```
Clock carClock(2, 10), driving_time(1, 25);
```

Which of the following function call will adjust the time in `carClock`?

- drivingTime.increase(carClock);
- carClock.increase(drivingTime);

Incorrect; this call has made `drivingTime` as the invoking object. It would have updated the `drivingTime` not `carClock`.

Incorrect, the argument for `pos` should be the second value in the parentheses.
OLI Learning Analytics During Class

Assessment overall versus individual questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Students</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 5</td>
<td>42</td>
<td>50%</td>
</tr>
<tr>
<td>Question 2</td>
<td>42</td>
<td>79%</td>
</tr>
<tr>
<td>Question 3</td>
<td>42</td>
<td>83%</td>
</tr>
<tr>
<td>Question 1</td>
<td>42</td>
<td>93%</td>
</tr>
</tbody>
</table>
OLI Learning Analytics during Class

- Grey – Students have not attempted enough activities to estimate learning
- Red – Low level of learning estimated.
- Orange – Moderate level of learning estimated.
- Green – High level of learning estimated
OLI Design Process

Learning objectives and their related skills

- Generate simple output
  - 3 pages
  - 4 skills

- Recognize and explain data types
  - Pages
    - User interaction
    - Type casting
    - The char data type
  - Skills
    - Add Existing Skill
    - Create New Skill
    - Recognize the data type for a given literal value
    - Recognize implicit type conversion

- Create conditional statements to handle different scenarios of a problem
  - 3 pages
  - 6 skills
**OLI Learning Analytics Post Class**

Organized by learning objectives and their related skills

- **Skill: Explain the use of constructors to create objects**
  - **Question:** Which of the following would properly invoke the copy constructor to make rightPedal a copy of the leftPedal object.
  - **Question:** What value would the left object get for its ID?  
  - **Question:** What value would the right object get for its ID?

- **Skill: Explain the effect of member functions**
  - **Question:** Enter the appropriate numbers to change the dimensions of the leftPedal object to 1 x 5. leftPedal.setSides().
    - **Part 1**
    - **Part 2**
OLI Analytics Post Class

Multiple Choice

Which method should we use to change the dimension for the ball object to 1 x 1?

Variables

Analytics

First Try Correct 4%
The percentage of students who submitted a correct response on the first attempt.

Eventually Correct 100%
The percentage of students who eventually submitted a correct response.

Relative Difficulty 0.54
The ratio of times a student either requested a hint or gave an incorrect answer to the total number of interactions. A higher ratio indicates greater difficulty.

Number of Attempts 253
The number of student responses submitted.

Analytics are calculated using data collected from several different sections of students who submitted responses to this question. This data can be used to evaluate the effectiveness and improve the content of this question.
OLI and Student Voices

**Engagement:** “I thought the OLI portion of the homework was very interactive and easy to follow along, especially with the short videos it proves as examples. I really enjoy and appreciate the way OLI breaks down common errors which in turn really helps solidify what to avoid when programming.”

**Engagement:** “This homework assignment was very creative. It allowed for us to use what we just learned in OLI in a real world scenario. We are given a starting point that is not too obvious but gives us a good foundation to build the rest of our program out of. I hope to see more of these in the future as I find them quite fun.”

**Inclusive classroom:** “I really like going over OLI pages in class, it clarifies any doubts or confusion I previously had. I also really like doing repl.it during class and having a walk through, I am a slow learner and I learn by doing so it really helps me out. I was partnered with [student] again today and I really enjoy working with him because he teaches me more based on his experience.”

**Building student confidence & professional identity:** “I really like how you're teaching the class. I feel like you are doing more modeling and then having us try stuff. I like when you teach something, then have us practice, and then you go over it and clarify any issues we may of had. Please keep giving and showing us examples.”
Impact of COVID for GOALS in CS Students

- **Lack of motivation:** “During COVID-19, my work ethic has severely decreased. I find that I am less motivated to complete work and if I get a bad grade on one of my assignments, I immediately lose motivation to do any other assignments that follow. I am trying to break this habit as well as the awfully negative mindset but it is pretty challenging!”

- **Difficulties studying with everyone home:** “It was tough as I live at home with my family which has 4 sisters, so studying was rough.”

- **Challenging circumstances:** “It drastically impacted me because I was homeless for a majority of COVID pandemic and having to do school work was extremely difficult but I was able to push through it and pass my classes.”

- **Despite these challenges, our data indicates we are successfully impacting students.**
Due to small Non-GOALS sample, data were weighted and variables recoded to evade violating test assumptions.
GOALS in CS
Impact – Efficacy

Figure 1. Comparing Students’ Efficacy: CS Redesigned & Non-Redesigned Introductory CS Classes
Fall 2019-Spring 2022

- 94% Agree
  - Student believes in ability to master CS knowledge & skills in future classes

- 81% Agree
  - Student puts enough effort in learning CS

- 90% Agree
  - Student spends a lot of time learning CS

* Significant difference p<.05
Figure 3. Students' Active Participation in CS Redesigned & Non-Redesigned Intro. CS Classes

GOALS in CS
Impact – Active Participation
GOALS in CS

Impact – Validation

Figure 6. Comparing Student Validation in Redesigned & Non-Redesigned CS Courses

Fall 2019-Spring 2022

- Students in Redesigned CS Courses
- Students in Non-Redesigned CS Courses

- Agree-
  *Felt comfortable asking CS instructors questions on misunderstood concepts
- Agree-
  *CS instructors understood my strengths
- Agree-
  *CS instructor helped me improve my performance in classes
- Agree-
  *Felt I mattered to CS instructor

81% 67%
60% 38%
82% 56%
79% 62%

* Significant difference p< .05
Figure 7. Comparing Cultural Relevance in Redesigned & Non-Redesigned CS Courses

Fall 2019-Spring 2022

- **Students in Redesigned CS Courses**
- **Students in Non-Redesigned CS Courses**

- **Agree-**
  - *Shared life experiences and interests in CS classes: 59%* (29%)
  - *Representations of my cultural identity/ies were included in CS course material/class topics: 48%* (30%)
  - *Created own meaningful examples/challenges: 70%* (62%)

*Significant difference p< .05
• One size does not fit all
• Active, adaptive learning demands more responsive feedback
• Learning analytics provoke reflection and refinement
• A great tool is essential but not enough:
  • Intentional conversations
  • Student voices
  • Interdisciplinary collaborations