Integrating Computational Thinking into a General Education Course

Stella A. Smith  
Georgia Gwinnett College, ssmith2@ggc.edu

Kris Nagel  
Georgia Gwinnett College, knagel@ggc.edu

David Kerven  
Georgia Gwinnett College, dkerven@ggc.edu

Follow this and additional works at: https://digitalcommons.georgiasouthern.edu/sotlcommons

Part of the Curriculum and Instruction Commons, Educational Assessment, Evaluation, and Research Commons, Educational Methods Commons, Higher Education Commons, and the Social and Philosophical Foundations of Education Commons

Recommended Citation  
Smith, Stella A.; Nagel, Kris; and Kerven, David, "Integrating Computational Thinking into a General Education Course" (2015).  
SoTL Commons Conference 5.  
https://digitalcommons.georgiasouthern.edu/sotlcommons/SoTL/2015/5
Integrating Computational Thinking into a General Education Course

DAVID KERVEN
GEORGIA GWINNETT COLLEGE
DKERVEN@GGC.EDU

KRISTINE NAGEL
GEORGIA GWINNETT COLLEGE
KNAGEL@GGC.EDU

STELLA SMITH
GEORGIA GWINNETT COLLEGE
SSMITH2@GGC.EDU
Agenda

What is Computational Thinking?
Let’s Jump In
Classroom Approach and Results
Connecting with the Community
How Can This Work for My Class?
Resources/Questions
Computational Thinking

“Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science.”

Georgia Gwinnett College

- Open access institution (currently 11,000 students), majority-minority student body

- Four-year state college located in suburban Atlanta, GA

- Two technology courses required in General Education
  - Introduction to Computing—AND—either Digital Media or Introduction to Programming
CT for Society

Health Care
• Software design principles and debugging applied to prescriptions of painkillers

Law
• POIROT Project on fraud investigation is creating a detailed ontology of European law
• SHERLOCK Project on crime scene investigation
CT for Society

Economics

Automated mechanism design underlies eCommerce, e.g. ad placement, online auctions, kidney exchange

Journalism

Crowd sourcing as a way of getting news tips from sources

Humanities—

Digging into Data Challenge: What could you do with a million books? (National Endowment for the Humanities)

Archeology

dHeritage Project, Microsoft Research Asia
Digital Forma Urbis Romae Project, Stanford
Cathedral Saint Pierre, Columbia
Digital Media and Learning Initiative MacArthur Foundation

Music, English, Art, Design, Photography, ...
Let’s Jump In and Solve a Problem

• Flowcharting the Baseball Player at Bat.

• Flowcharting Symbols
  • Start Symbol – 1 arrow out
  • Stop Symbol – 0 arrows out
  • Step Symbol – 1 arrow out
  • Decision Symbol

- Question?
  - No
  - Yes
Baseball Player at Bat

Start

Pitcher Throws

Umpire Yells "Strike!"

Does Batter Hit?

Yes

Batter Runs To First Base

No

Batter Swings

Umpire Yells "Strike!"

Stop
How would you depict three strikes?

Start

Pitcher Throws

Start

Pitcher Throws

Batter Swings

Batter Swings

Does Batter Hit?

Yes

Batter Runs

Batter Runs To First Base

No

Umpire Yells "Strike!"

Is Third Strike?

No

Stop

Yes

Stop

Yes
Classroom Approach and Results

• Integrate activity-based learning modules that stress CT skills into existing course content:
  • Working with Data. Examples:
    • Creating Hardware Compatibility Charts
    • Using MS Office for Data representation
  • Process Modeling. Examples:
    • Creating Cryptography Flowcharts
    • Creating Network Packet Animations

• Evaluate Students Regarding CT Skills
  • Skills Assessments Integrated with Class Content
  • Pre- and Post- Evaluations
## Sample Assignments & CT Skills

<table>
<thead>
<tr>
<th></th>
<th>PSU Calculator</th>
<th>Component Compatibility</th>
<th>General Education Tracking</th>
<th>Cryptography</th>
<th>Network Simulation</th>
<th>Stop Light</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Collection</strong></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data Analysis</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data Representation</strong></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>Algorithms</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Automation</strong></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Simulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Working with Data
Pre- and Post-Assessment

Professor Ann Mesia has met with you to seek your help with a problem she is having in mentoring students. She needs a way to track and quickly see if her mentees have completed Area C of GGC’s general education requirement. Select one of the Office tools and use it to create a solution that will help Dr. Mesia quickly and easily see who has taken what courses, and quickly determine who has completed part or all of area C.
GGC General Education - Area C

Area C - Humanities/Fine Arts (6 hours)

Choose one from the following:
MUSC 1100/ARTS 1100/ENGL 2110/2100/FILM 1005
Choose one from the following:
RELN 1100/GEOG 1101/2000 level foreign lang
## Assessment – Student Answers

### Computational Thinking Diagnostic

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Classes Taken:</th>
<th>Class C Completion:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rand</td>
<td>Interm. Italian, MUSC 1100</td>
<td>✔️</td>
</tr>
<tr>
<td>Egwene</td>
<td>ENGL 2100, GEOG 1101, ARTS 1011</td>
<td>✔️</td>
</tr>
<tr>
<td>Perrin</td>
<td>RELN 1100, GEOG 1101, ENGL 2100</td>
<td>✔️</td>
</tr>
<tr>
<td>Elayne</td>
<td>ARTS 1100, FILM 1005, Interm. Italian, ARTS 1101</td>
<td>✔️</td>
</tr>
<tr>
<td>Mat</td>
<td>French 1, Chinese 1, MUSC 1100, *Spanish</td>
<td>✗</td>
</tr>
</tbody>
</table>

**Key:**

- ✔️: Completed
- ✗: Not Completed
- *(would like to take)*
### Assessment – Student Answers

<table>
<thead>
<tr>
<th>Student</th>
<th>MUSC 1100</th>
<th>ARTS 1100</th>
<th>ENGL 2110/2100</th>
<th>FILM 1105</th>
<th>RELN 1100</th>
<th>GEOG 1101</th>
<th>2000 Level Foreign</th>
<th>Requirement Fulfilled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>P</td>
<td>Yes</td>
</tr>
<tr>
<td>Elayne</td>
<td>N/A</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>P</td>
<td>Yes</td>
</tr>
<tr>
<td>Perrin</td>
<td>N/A</td>
<td>N/A</td>
<td>P</td>
<td>N/A</td>
<td>F</td>
<td>N/A</td>
<td>P</td>
<td>Yes</td>
</tr>
<tr>
<td>Egwene</td>
<td>N/A</td>
<td>P</td>
<td>P</td>
<td>N/A</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Rand</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>P</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Pre/Post Assessment - Module Evaluation

• Student Issues
  • Lack of Problem Decomposition
    • Purpose of Exercise
    • Failure to Use Available Resources
      • GGC Catalog
      • Faculty Advisor (me)
  • Lack of Planning for Representation of Solution
    • Readability Issues
    • Color Usage
  • No consideration of automation

• Lessons Learned
  • Many students do not know where to begin when posed with the problem.
  • Students make assumptions regarding the problem without researching the correct answer.
### ITEC 1001 – Dr. Ann Mesia and Area C Sample Solution

<table>
<thead>
<tr>
<th>Complete?</th>
<th>Fine Arts</th>
<th>Global Culture</th>
<th>Other Courses Not in Area C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rand</td>
<td>MUSC 1100</td>
<td>Intermediate Italian</td>
<td>ENGL 1101 &amp; 1102, ARTS 1011</td>
</tr>
<tr>
<td>Eqwene</td>
<td>ENGL 2100</td>
<td>GEOG 1101</td>
<td>RELN 1100 (failed)</td>
</tr>
<tr>
<td>Perrin</td>
<td>ARTS 1100, FILM 1005</td>
<td>Intermediate Italian</td>
<td>ARTS 1011</td>
</tr>
<tr>
<td>Elayne</td>
<td>MUSC 1100</td>
<td></td>
<td>French 1001 &amp; 1002, Chinese 1001 &amp; 1002</td>
</tr>
</tbody>
</table>
Assessment – Model Answer 2

MS Excel

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Fine Arts</th>
<th>Global Culture</th>
<th>Complete?</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rand</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Egwene</td>
<td></td>
<td>yes</td>
<td>no</td>
<td>ENGL 1101 &amp; 1102, ARTS 1011</td>
</tr>
<tr>
<td>Perrin</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>RELN 1100 (failed)</td>
</tr>
<tr>
<td>Elayne</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>ARTS 1011</td>
</tr>
<tr>
<td>Matt</td>
<td>yes</td>
<td></td>
<td>no</td>
<td>French 1001 &amp; 1002, Chinese 1001 &amp; 1002</td>
</tr>
</tbody>
</table>
When a company posts a privacy policy, it ensures that the company keeps confidential all the information it collects on users.
(True or False)

“Net neutrality” refers to
a) The postings on websites that are nonpartisan
b) A promise by users of some websites that they will not make critical comments
c) The way Wikipedia editors are instructed to handle new entries on their site
d) Equal treatment of digital content by internet service companies

Source: Pew Internet Research, Web IQ Quiz
Our Web IQ?

• Six in ten internet users (61%) are able to correctly identify the phrase “Net Neutrality”

• Fewer than half (44%) are aware that when a company posts a privacy statement, it does not necessarily mean that they are actually keeping the information they collect on users confidential

• What is the implication for computational thinking?
  • political issues
  • institutional policy
  • Economics

Source: Pew Internet Research, Web IQ Quiz
http://www.pewinternet.org/quiz/web-iq-quiz/
Fewer Students Are Majoring In Computer Science, Education And English

“Surveys of employers show hiring managers are looking at more than just what someone's major in college was; they want applicants who are well-rounded with skills in both the liberal arts and from what they could pick up in STEM classes.”

One Approach:
Outreach to K-12 Students and Teachers

• Engaging, interactive hands-on computing
  • Summer Camps
  • Super Saturday Series

• Teachers asked to attend
  • One-Day Professional Development Workshop, 2013
  • Separate from students, but shared experiences
# Computational Thinking Workshop

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>Introduce Presenters and Comp Thinking</td>
</tr>
<tr>
<td>9:45</td>
<td>Join MS Girls session on Scratch</td>
</tr>
<tr>
<td>10:20</td>
<td>Hands-on Scratch projects</td>
</tr>
<tr>
<td>11:45</td>
<td>Networking Lunch</td>
</tr>
<tr>
<td>12:30</td>
<td>Guest Speaker, Mel Chula on HFOSS</td>
</tr>
<tr>
<td>1:00</td>
<td>Connecting to your Curriculum</td>
</tr>
<tr>
<td></td>
<td>Create a Lesson Plan</td>
</tr>
<tr>
<td>2:00</td>
<td>Share lesson plans</td>
</tr>
<tr>
<td>2:15</td>
<td>CS Unplugged Activity</td>
</tr>
<tr>
<td>2:50</td>
<td>Wrap-up</td>
</tr>
</tbody>
</table>
Workshop Goals

• Enable teachers from variety of disciplines to integrate computational thinking concepts within their curriculum

• Provide examples and tools to use
  • Teacher use tool to create simulation for concept investigation
  • Students use tool to create a product and learn concept through implementation

• Develop and share specific lesson plan for one lesson
Participants and Survey Results

- 17 female participants, majority current middle school teachers with average 13.4 years experience teaching Metropolitan Atlanta schools
Using Computational Thinking in their Class

• “Learning how to create a program using Scratch to use immediately in my classroom.”
• “The collaboration opportunities (networking) and the idea that I CAN teach this in my classroom”

I can use what I learned in the workshop in the classes I teach

The learning activities in this workshop were effective.
Integrating Computational Thinking into a General Education Course

Thank you – Any Questions?

DAVID KERVEN
GEORGIA GWINNETT COLLEGE
DKERVEN@GGC.EDU

KRISTINE NAGEL
GEORGIA GWINNETT COLLEGE
KNAGEL@GGC.EDU

STELLA SMITH
GEORGIA GWINNETT COLLEGE
SSMITH2@GGC.EDU