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# Implementing Cutting-Edge Devices To Make Programming Course "Fun" For STEM Students

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**GEORGIA GWINNETT COLLEGE**

**Georgia Scholarship of STEM Teaching and Learning Conference 2015**

# ICE-DIP

## Integrating Cutting Edge Devices In Intermediate Programming

# Importance of STEM

- *"One of the things that I've been focused on as President is how we create an all-hands-on-deck approach to science, technology, engineering, and math… We need to make this a priority to train an army of new teachers in these subject areas, and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve."*

  President Barack Obama
  Third Annual White House Science Fair, April 2013

- *The Technology Association of Georgia forecasts that there will be 218,000 Georgia jobs in STEM fields by 2018 … and a significant shortage of qualified applicants to fill those jobs.*

  www.tagedonline.org

- *Georgia will be the first state in the South to join a growing national initiative that seeks to increase the supply of outstanding teachers in the science, technology, engineering and math (STEM) fields and to change how they are prepared to teach.*

  Governor Nathan Deal, March 2014 http://gov.georgia.gov/press-releases/2014-03-03/deal-georgia-join-national-teaching-fellowship-program

# Information Technology Sector*

## HIGH DEMAND CAREERS

| | |
|---|---|
| Application Developer | IT Security Administrator |
| Business and Operations Analyst | JAVA Developer |
| Business Consultant* | Network Security Specialist |
| Business Support Services | Oracle Developer & DBA |
| Computer Programmer | Process Improvement Manager |
| Computer Scientist | Researcher |
| Cyber Security* | Salesperson |
| Data Analyst | Software Developer* |
| Data Scientist | Strategic & Sourcing Consultant |
| Electrical Engineering | Web Developer |
| Enrollment Consultant | Windows Developer |
| Field Service Engineer | Wireless Communication Engineer |
| Game Developer | |

*=Identified by 2 or more companies

## HIGH DEMAND SKILLS AND ATTRIBUTES

| | |
|---|---|
| Ability to get along with others | JAVA |
| Analytical Mindset | Lifelong Learner* |
| Bilingual | Math Degrees |
| Business Acumen* | Mobile Application Development |
| Business Intelligence | Presentation Skills |
| Communication | Programming Languages (C#, C++, Python) |
| Critical Thinking | Project Management* |
| Customer Service* | Spectrum & Frequency Planning |
| Data Analytics* | Statistics Degree |
| Defense Acquisition Workforce Improvement Act (DAWIA) Certifications | Supply Chain |
| I.T. Certifications* | Virtual Learning |

*=Identified by 2 or more companies

*From Georgia *Governor's High Demand Career Initiative Report*, December 2014

# Information Technology Sector*

…

*The information technology sector in Georgia currently has one key concern—finding enough employees with the right skills to fill their vacancies. Many companies discussed long searches to fill vacancies and "stealing" back and forth between employers. Companies emphasized that Georgia needs to increase its IT talent pool, but that any initiatives should be targeted to specific needs (i.e. software developers instead of help desk technicians).*

**Sector Highlights**

*Many employers stated that they had to look outside the state of Georgia to find sufficient IT talent. For example, 65% of Home Depot's software developers are recruited from out-of-state which results in high relocation costs and the need for satellite offices around the country.*

…

*From Georgia *Governor's High Demand Career Initiative Report*, December 2014

# Georgia Gwinnett College: Vision and Mission

Georgia Gwinnett COLLEGE

[1]Georgia Gwinnett College Web page, http://www.ggc.usg.edu/about-ggc
[2]School of Science and Technology Mission, http://www.ggc.usg.edu/academics/school-of-science-and-technology
[3]Engage magazine Fall 2014, http://fall2014.engage.ggc.edu/nursing-stem-programs-have-new-home-at-ggc/

# General IT Statistics and Trends

- Number of students declaring IT major
  - 1017 (of 10,700) at GGC
  - 9.5% of students at GGC
  - 42% are Software Development

# How ICE-DIP Could Impact Students

**Retention**

**Student Motivation**

- Interest
- Real-World
- Excitement
- Self-Efficacy

**Student Attitude**

- Relates to motivation
- Relates to perseverance

# Cutting Edge Devices

Impacting Students

Oculus Rift

Muse

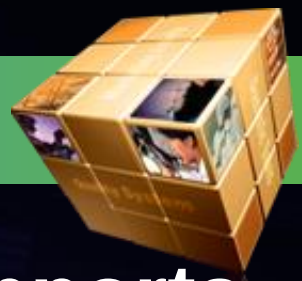
Processing

**Intermediate Programming**

Leap Motion

Android Mobile

# Leap Motion

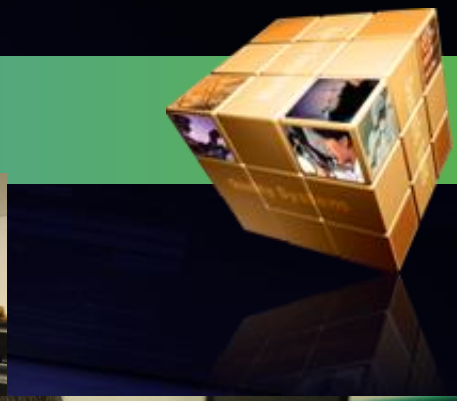


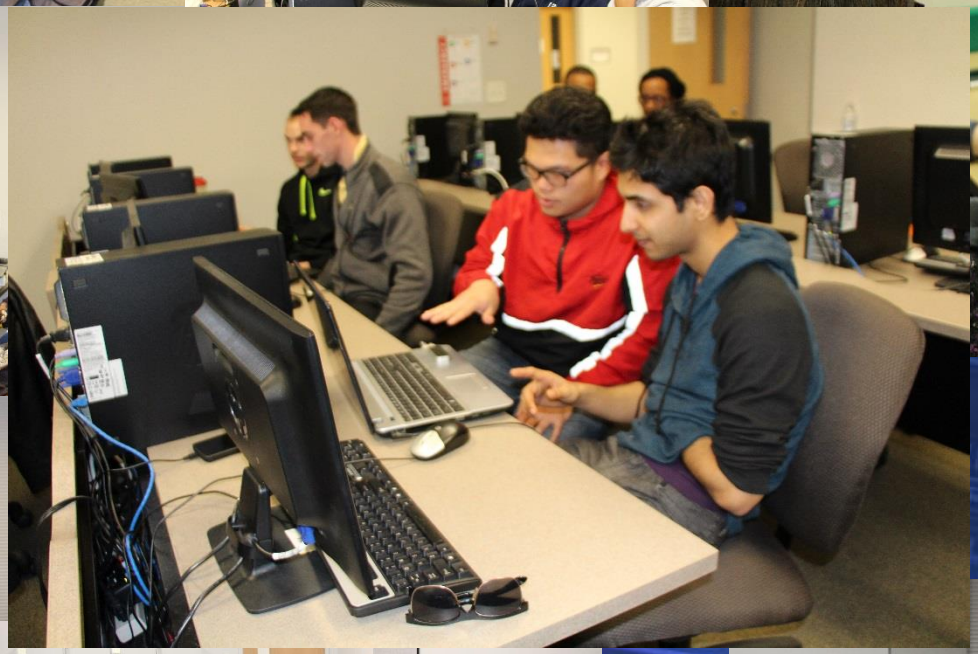
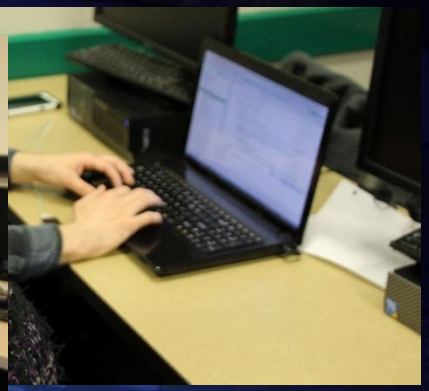
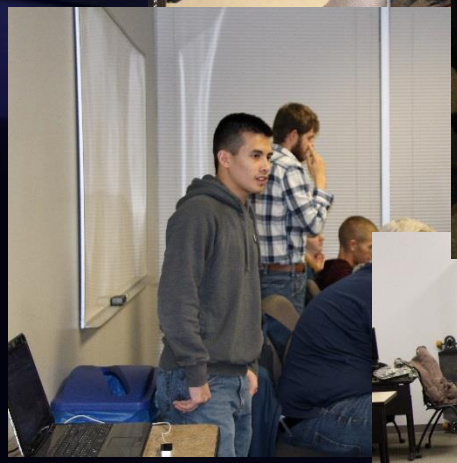
- **Hardware sensor device that supports hand and finger motions as input**
  - Point, wave, reach, grab
- **Uses infrared LEDs and small cameras**
- **Inexpensive when compared to Kinect**

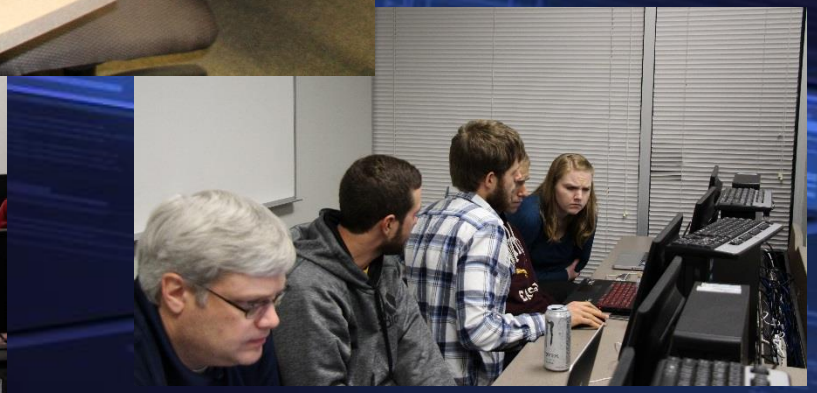
# Curriculum – Leap Motion

- Objectives
  - **Intended to reinforce concepts of understanding an API, inheritance, lists and arrays**
- Curriculum Writing Process
  - **System the Leap would be installed on was unknown, needed to reduce exercise to lowest common denominator**
  - **Abandoned original idea of “Morse code” through Leap**
  - **Conductor - different gestures would play a different set of notes**
  - **The right hand would play the notes in ascending progression, the left hand would play the descending progression**







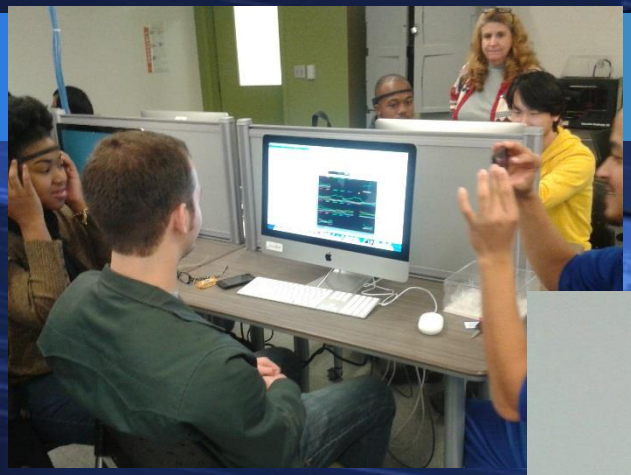
# Muse

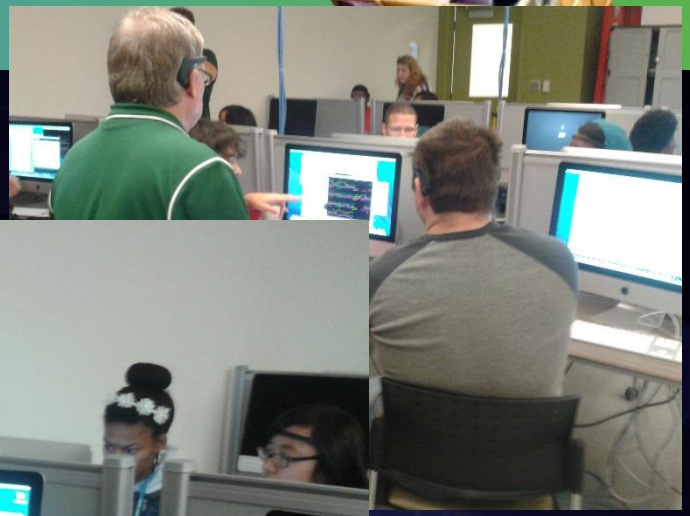
- **Brain computer Interface (BCI) device to measure brain electrical signals using** electroencephalography (EEG)
- **Fits in the popular emergent wearable sector, detects five bands:**

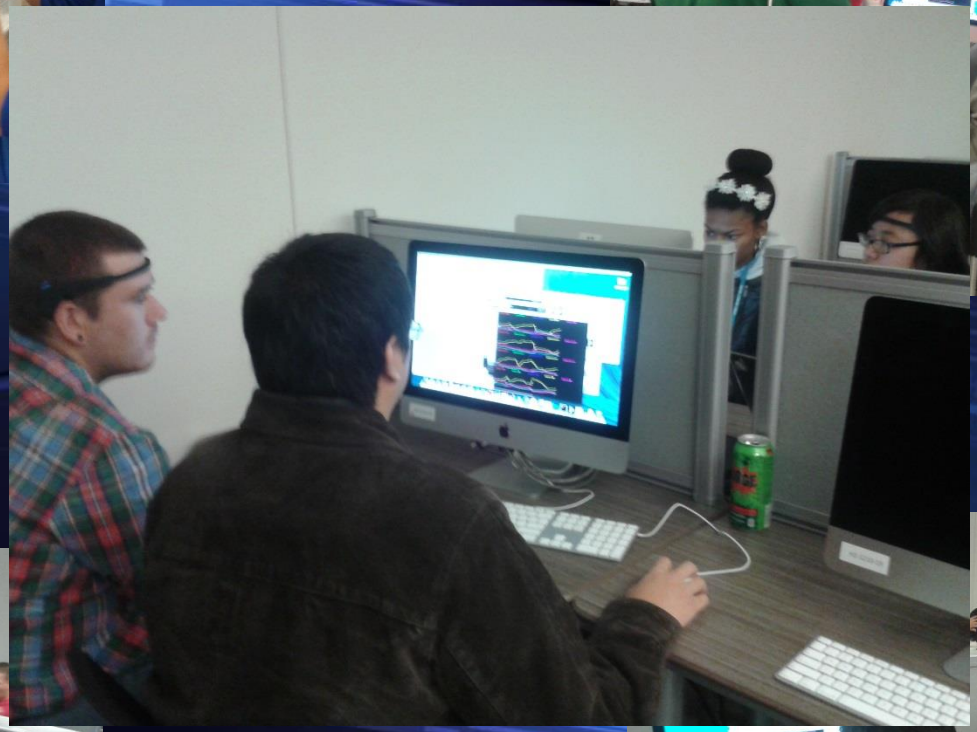
  - Delta waves which are most present during sleep.
  - Theta waves which are associated with sleep, very deep relaxation, and visualization.
  - Alpha waves which occur when relaxed and calm.
  - Beta waves which occur when, for example, actively thinking or problem-solving.
  - Gamma waves which occur when involved in higher mental activity and consolidation of information.

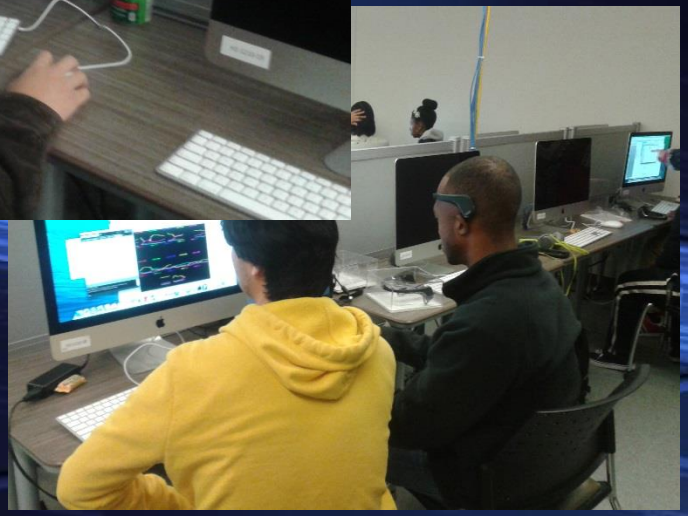
# Curriculum – Muse

- Objective
  - Increase engagement and strengthen course concepts, leveraging enthusiasm over BCI device
- Curriculum Writing Process
  - Survey existing tools/APIs/libraries/docs/examples
  - Match to course content
    - Integrate Processing to visually monitor the input from the Muse
    - Modify an array to an array list (for Color)
    - Sonify eye blink detection
    - Refactor the Wave class to extend LinkedList
    - Algorithmically recovering from signal loss when an interruption in service occurs









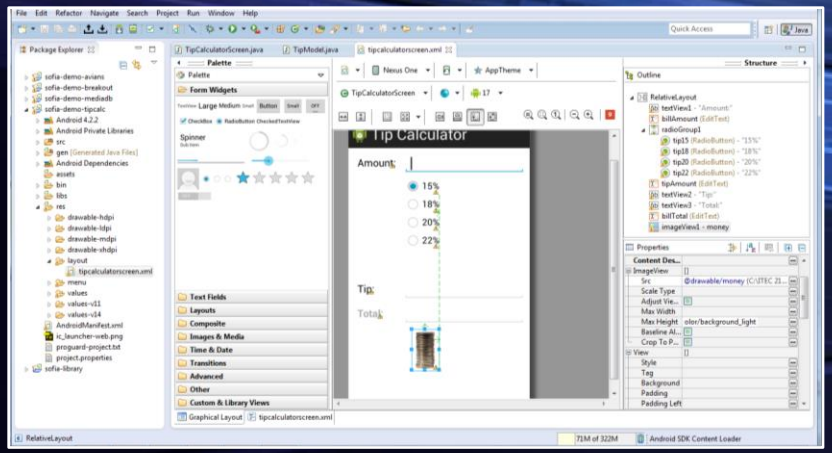
# Android Mobile Development

- Android Mobile Development
  - Builds on Java and Eclipse knowledge
- Simplified Open Framework for Innovative Android Applications (Sofia)
  - Developed by a team at Virginia Tech
  - Focused on domain knowledge and insulated student from advanced concepts such as:
    - Event Handling
    - Binding GUI elements to Java code
    - User interaction coding

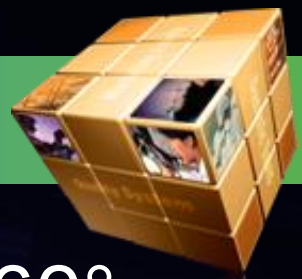
http://sofia.cs.vt.edu/sofia-2114/book/index.html

# Curriculum – Android Mobile

- Objective
  - Leverage interest in mobile devices to reinforce CS1 course concepts
  - Place a mobile UI on previously written code
- Curriculum Writing Process
  - Survey existing tools/APIs/libraries/docs/examples
  - Match to course content
    - Utilized a tip calculator class
    - Utilized a binary to decimal, decimal to binary recursive utility class written by students



# Oculus Rift



- A 3D emulation device that does 360° head tracking, allowing students to explore a virtual world
- Today's students are aware of the device and express high interest
- No curriculum developed; students could test drive

# Grading Assignments

- Effort grade vs. content grade
  - Because of the uncertainty and scarce equipment, assignments are time bound rather than by strict objective
  - Class attendance was required for hardware devices
- Advice
  - Modularize assignments to allow for unforeseen
  - Have a strong policy for how you will handle make up work
  - Strongly monitor progress of each of the teams in the course – you must keep them on track
  - Recruit help in the classroom!

# Funding

- **Monies obtained from institution's internal funding: *STEM Mini Grants Program, GGC School of Science & Technology, USG-STEM Initiative II***
- **Long approval process**
- **Delayed purchasing**
- **Need to accommodate for unforeseen delays**
- **RESULT: 11 Leaps, 11 Muse and 3 Rifts**

# Equipment – Installation Issues

- No issues
  - Processing
    - Free, simple, open source and lots of examples
    - Students could use at home, supports Mac OS, Linux, Windows
- The most challenging issue
  - Leap Motion
    - Requires administrative privileges
      - Student were asked to pair up
      - Each team needed their own notebook
    - Only one undiagnosed unsuccessful installation
    - Supports USB 2.0
    - Supports Mac OS, Linux, Windows

# Equipment – Installation Issues

- The most challenging issue
  - Android/Sofia
    - Requires Eclipse, Android Development Tools (ADT) and Sofia installation
    - Requires creating a virtual device for emulation successfully
    - Requires understanding the Android SDK Manager if student tries to use their phone
    - Requires a lot of memory
    - Extremely time consuming
      - Downloads
      - Multiple notebooks cause configuration issues
    - Patient students could install at home, supports Mac OS, Linux, Windows
    - Supports Mac OS, Linux, Windows

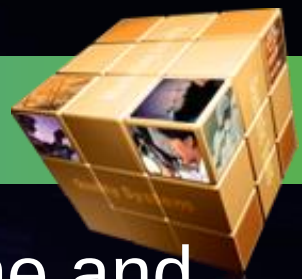
# Equipment – Installation Issues

- The most challenging issue
  - Muse
    - Requires administrative privileges to install
    - Requires Bluetooth
      - Cannot depend on student notebooks having Bluetooth
      - Installed in Digital Media lab (all newer Macs with Bluetooth support)
      - Bluetooth pairing is a problem – all machines see all activated devices
      - Also required Processing to be on the machines
    - Extremely time consuming
      - Downloads
      - A single professor did all of the installation
    - Supports Mac and Windows
  - Rift ???
    - Were not able to implement so unknown

# Other Issues

- Timeline and procurement
- Muse
  - Leading (bleeding!) edge: very little code examples, limited forum discussions and no native library support
- Leap Motion
  - None of the examples were suitable for the knowledge level of the students
  - Gestures did not perform as well as anticipated

# LESSONS LEARNED



- Do not underestimate the amount of time and knowledge required to install and implement the devices
  - Technological difficulties, readiness of the development kits provided by small companies
  - Administrative impediments
  - Availability of supporting desktops/labs
- The marketing for a device often does not match the capability
- Inventory management is not easy

# LESSONS LEARNED

- Plan on multiple hours of faculty preparation time per minutes in class
  - Curriculum development based student abilities is difficult
  - We are learning as they do
  - Many of the examples are open source and do not work
  - Without competent coders as instructors, the project would have been difficult
- You can never predict when a vendor will pull a product
- The unforeseen will always happen

# Quantitative Findings (Cheol)

- What was done
  - Clumping Data
    - Pre and Post Surveys

| | |
|---|---|
| Confidence Construct (C): | students' confidence in their own ability to learn computer science skills; |
| Interest Construct (I): | students' interests in computer science; |
| Gender Construct (G): | students' perceptions of computer science as a male field; |
| Usefulness Construct (U): | students' beliefs in the usefulness of learning computer science; and |
| Professional Construct (P): | students' beliefs about professionals in computer science. |

# PRELIMINARY FINDINGS - QUALITATIVE

- This is "real-world" …
- Relevance was a MAJOR theme
- Positive affective response
- Retention:
  - Sense of challenge
  - Interest / Enjoyment
  - Value
  - Perception of difficulty
  - Perception of challenge – work ethic

# “Programming is a challenge…”

- I am not afraid of failing and I am determined to learn programming because it will provide me with a variety of opportunities, some of which I might be able to do from the comfort of my home office in my pajamas. And because I will not be beaten!

# “I Enjoy Programming…”

- “…It started growing on me as time went by and I actually enjoy it now. That feeling when I complete a program is really satisfying, even if I find later that I did a little (or A LOT) wrong.

# “Programming is Difficult…”

- hard to understand at this age
- get in over there head
- not a very easy subject
- course load is very high
- a large and steep difficulty curve
- “It is very time consuming and requires dedication most students don't fit the criteria.”

# “Programming Requires Work…”

- give up too easily
- if you have the determination to learn, it SHOULD come to you.
- It takes a lot of practice to understand. If a student is not willing to do so they will want to take the easy way out and drop the class.
- if you have the determination to learn, it SHOULD come to you.

# Relevance

- My goal in the class was to learn how people think programmatically. And that has increased. And that has helped me in that I know see that programming is more important ( to my career).

# Self-Efficacy – Students Who Persevered

- Interest: 18.9%
- Enjoyment: 21.6%
- Usefulness: 10.8%

# Self-Efficacy – Students Who Left

- Programming is “difficult”: 45.9%
- Did not put in time: 8.1%
- Difficult/not enough time: 8.1%
- Difficult/overwhelming: 8.1%

- Failure due to programming itself
- Locus of control – within self

# Student Belief Model

Enjoyment of Challenge

Interest

Value

**Difficulty**

Lack of Effort

Overwhelmed

Ability

Retention in Programming

# Qualitative Results - Affective

- Positive affective response
  - “Before I thought learning Java is really boring…(it) has made me enjoy it.”
  - “Pretty cool…”
  - “It was neat to see and inspiring.”
  - “Pretty awesome!”
  - Plus more…

# Qualitative Results - Affective

- “It helped me learn concepts being taught in class by being able to see the actual code at work and what it does. Seeing in real time what code actually does made these technologies relevant for me.”

# In Summary

1. Programming – Root of Brain Drain
2. Why Georgia Gwinnett College?
3. Lessons from the Road
4. Pilot Results – Preliminary Stories

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# Thank You !