Gesture-Based Learning System for STEM Education

SciKids

Gwen Morris, Claudia Coronel, Samantha Earl
Sponsor: Elizabeth Glass
Mentor: Austin Sanders

Scikids Client/Mentor

- Elizabeth Glass
  - Director of Career Development
- Austin Sanders
  - Graduate student

NORTHERN ARIZONA UNIVERSITY

College of Engineering, Forestry & Natural Sciences

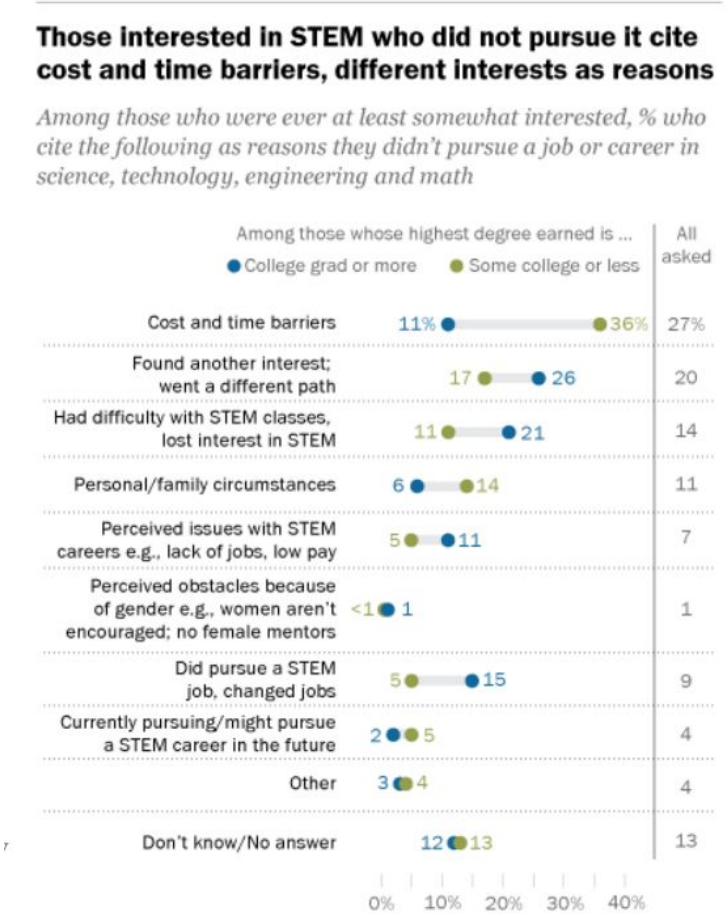
School of Forestry

Figure 1 - Elizabeth Glass

Problem Statement and Solution

General Problem

- Market for STEM
  - Rapid job growth in comparison to workforce
- Major reasons:
  - Cost and time barriers
  - Loss of interest
  - Outdated materials
- Sponsor Interest



Solution

Extensible, mobile, gesture-based learning system

Cost and time barriers	→	Be openly **available** to community
Loss of interest	→	Provide information in a **visually rewarding** way
Outdated materials	→	**Up to date** information in STEM

Requirements

1. Interaction with gestures
2. Save profiles and personalized modules
3. Store personal progression and high scores
4. Intuitive and easily extensible for future programmers

Architectural and Implementation Overview

High Level Overview

- Navigational system (GUI)
- Local SQLite Database
- Gesture Mapping
  - Intel D435
  - Nuitrack SDK
- Scene Backend
- MVC?

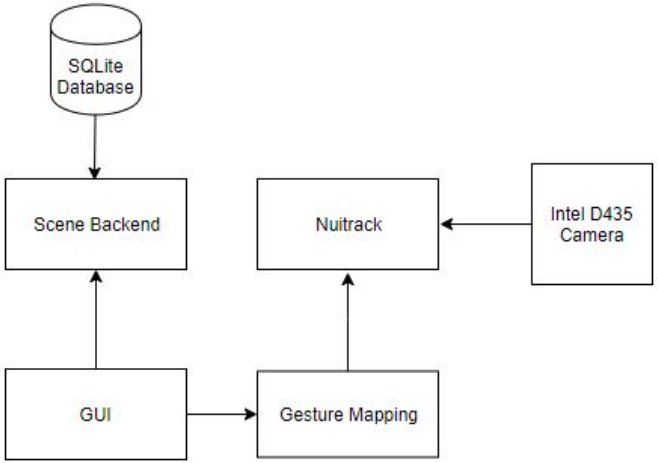


Figure 2 - Architecture Diagram

Implementation Overview

- Intel RealSense D435 Camera
  - Has built-in depth sensors, RGB sensor, and infrared projector.
- Nuitrack
  - Middleware with gesture recognition
- Unity
  - A versatile game development platform

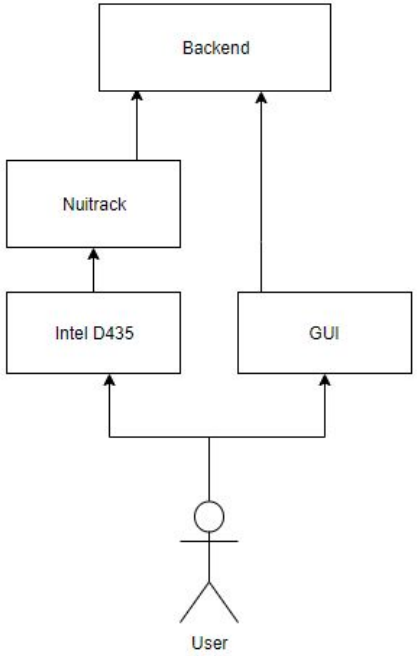


Figure 3 - System Diagram

GUI/Database

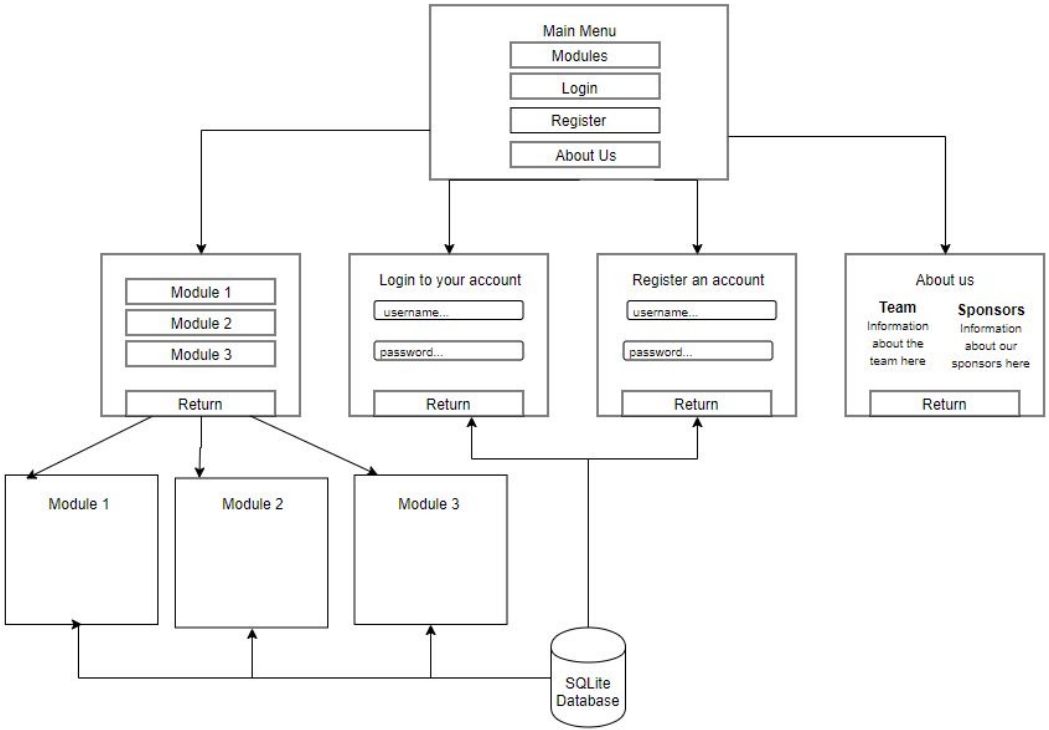


Figure 4 - Menu Layout

Scene Backend

- Contains the environments and menus of the project
- C# scripts, sprites, prefabs, animations, etc.
- Scenes in our system:
  - Login
  - Registration
  - Each module
- Extensible

Figure 5 - Login scene and backend

Gesture Mapping

- Nuitrack - full body skeletal tracking software with gesture recognition

- Hand Tracker module

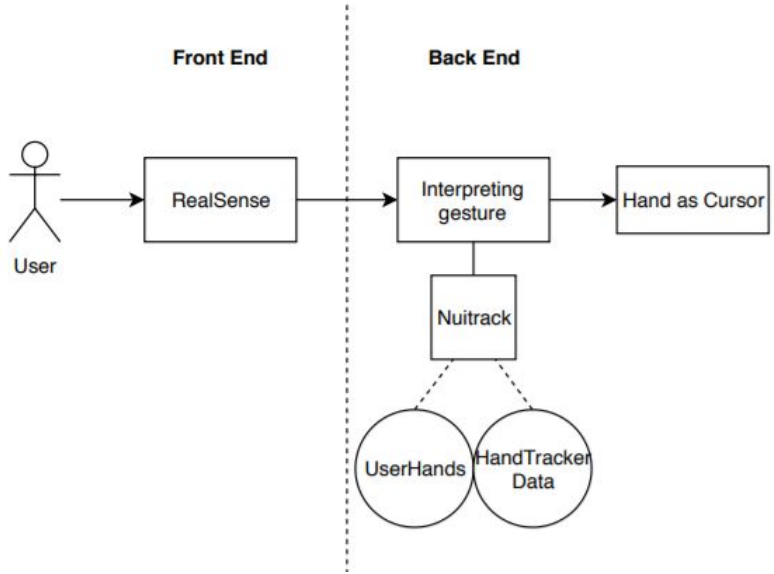


Figure 6 - Gesture Diagram

Prototype Review

Setup

- The user connects the camera to the computer before beginning the application.

- The user stands in front of the camera to interact with the software.

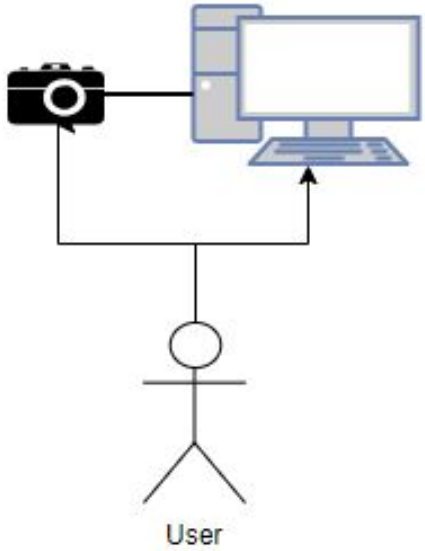
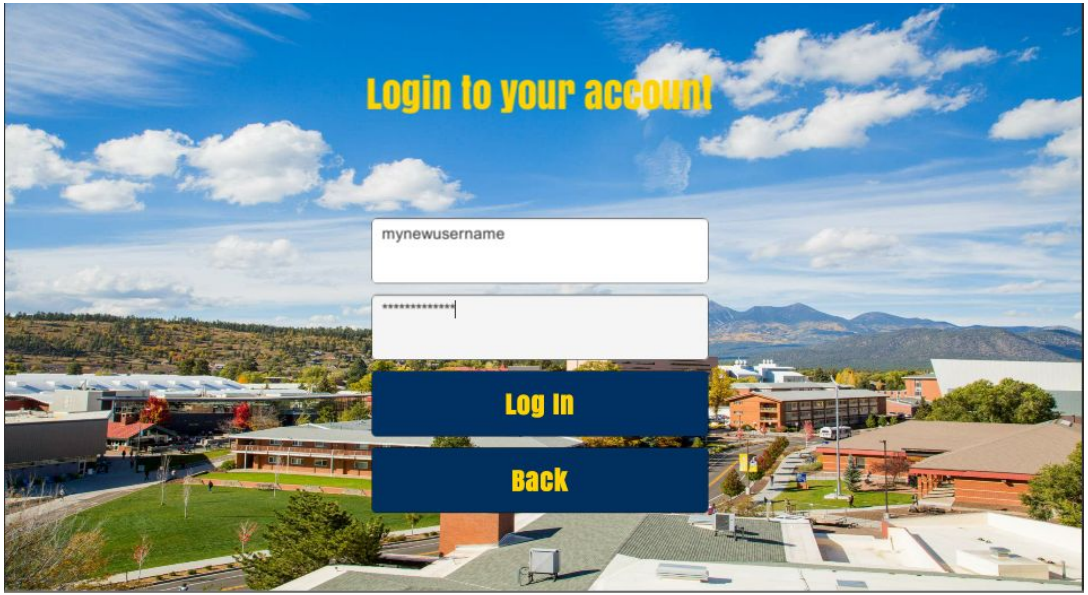


Figure 7 - Setup

Login System



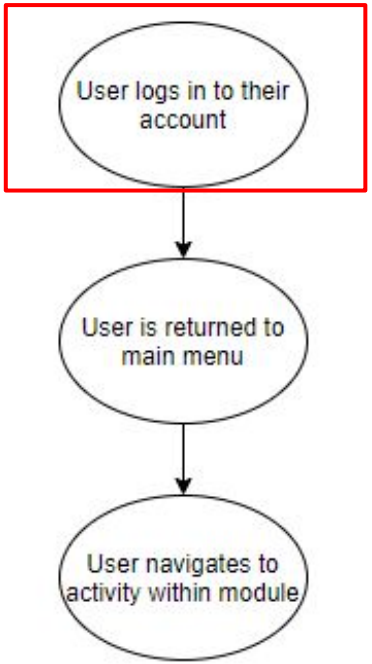


Figure 8 - Flow diagram

Login System continued...

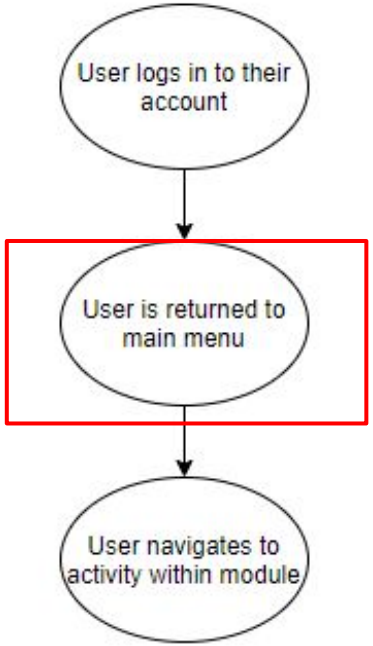


Figure 8 - Flow diagram

K-5 Module

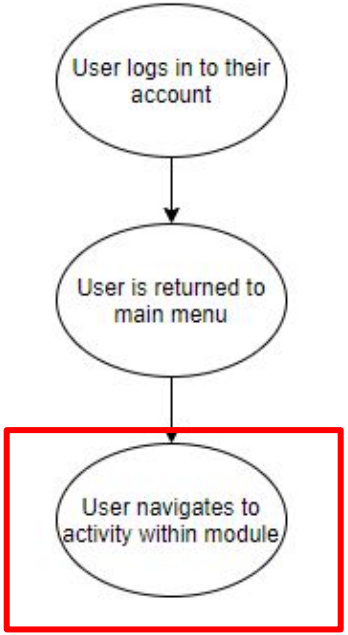


Figure 8 - Flow diagram

Community College Module

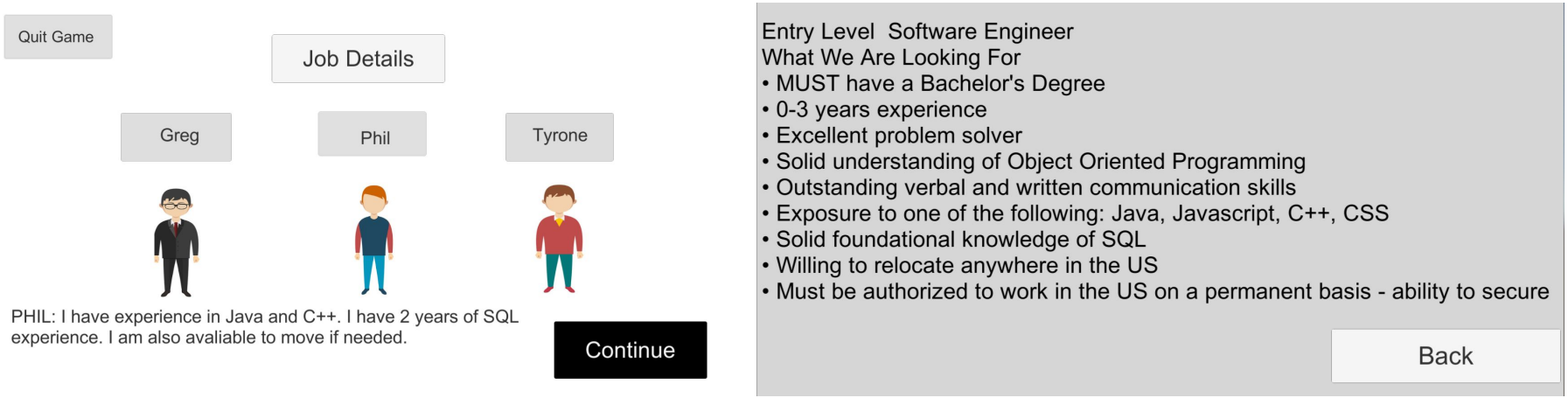


Figure 9 - Community College Module

Implementation challenges, Schedule

Challenges and Resolutions

Technology Risks

- New technology.
  - **Challenge**: Lack of community support
  - **Resolution**: Nuitrack forums

- Accuracy issues
  - **Challenge:** High sensitivity
  - **Resolution:** Recalibrating config files

Business Risks

- Learning curve
  - **Challenge:** Users memorization
  - **Resolution:** Tutorials

- User Fatigue
  - **Challenge:** Muscle fatigue
  - **Resolution:** Time limits

Schedule

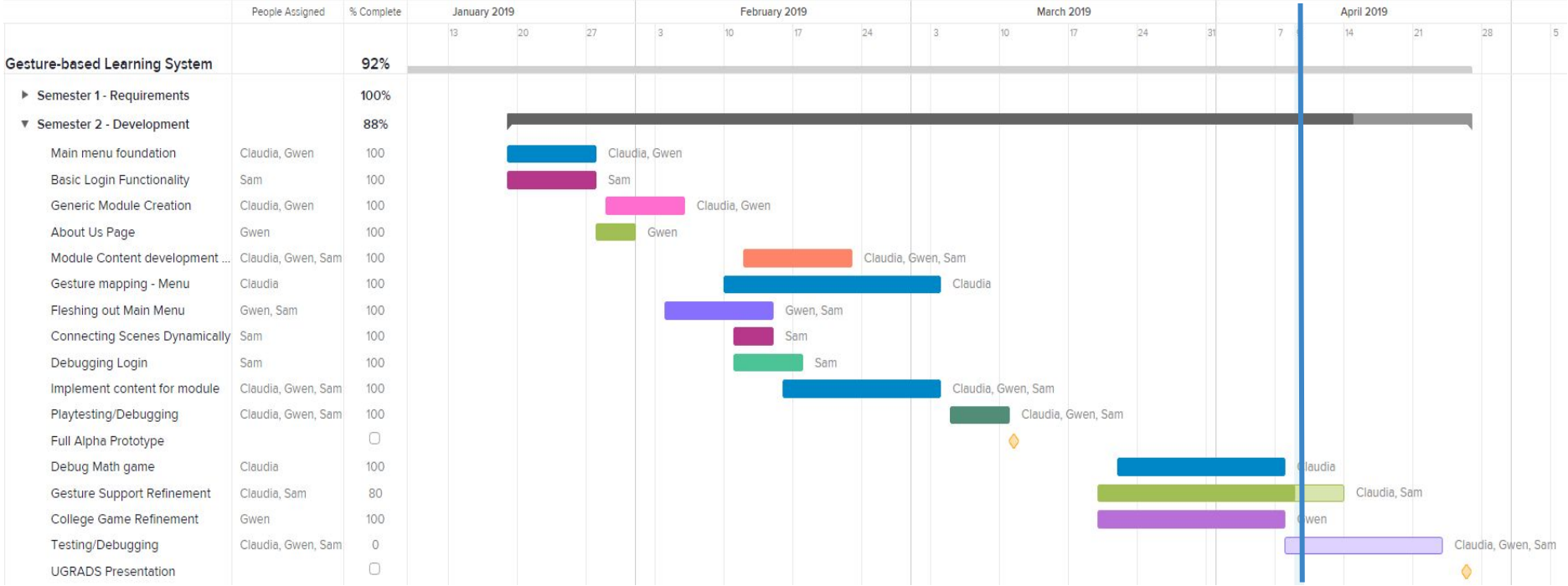


Figure 10 - Gantt Chart

Testing Plan

Unit Testing

- Using Unity TestRunner
- 5 test classes

Test	Sample Input/Action	Expected Outputs
UserFound()	Stand in front of camera	“User found” text
HandTracking()	Waves hand	coordinates of hands
ItemDestroyed()	User touching items in game.	text displaying “Destroyed”

Integration

Integration Test	Sample Input	Expected Output
Math activity has access to databse	User sets high score	userScore in table updated.

Usability

Purpose:	engaging and enjoyable system
Task:	Access modules and activites
Plan:	Taking at least two individuals for each of the modules we have developed and asking them their opinions on the content. Posing the right questions based on graphics and gestures.
Survey	● Did you find the material engaging and informative? ● On a scale of 1-10 how enthusiastic were you to continue? ● Would you use this system again?

Summary

Future Work

- New module development
- Gesture support

Conclusion

- Team SciKids, working with Elizabeth Glass
- Growing need for STEM workers
- Gesture based learning system
- Prototype:
  - Login system, personal progression, gestures, gamification
- Testing plan:
  - Unit, integration, usability
- Future:
  - Finalize tests
  - Write out user documentation