

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



Figure 1 - Elizabeth Glass

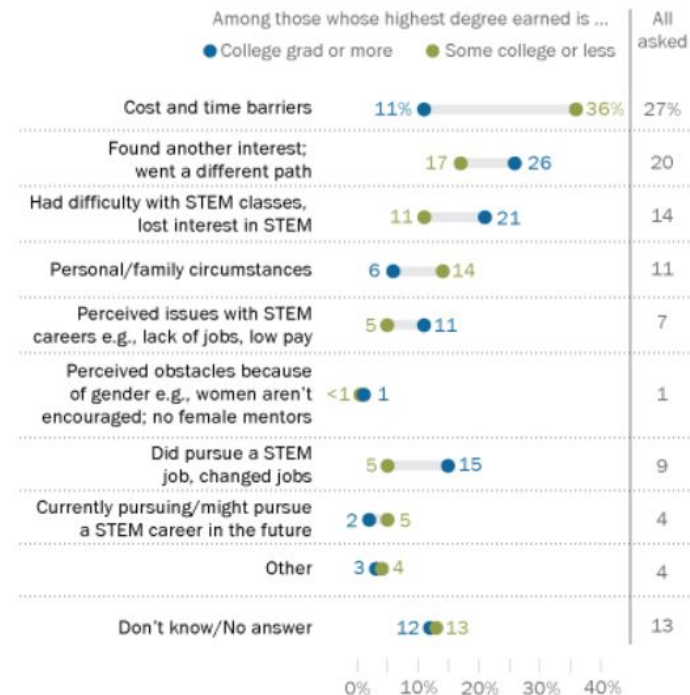
Problem Statement and Solution

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 - Outdated materials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

Those interested in STEM who did not pursue it cite cost and time barriers, different interests as reasons

Among those who were ever at least somewhat interested, % who cite the following as reasons they didn't pursue a job or career in science, technology, engineering and math



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Outdated materials  **Up to date** information in STEM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?

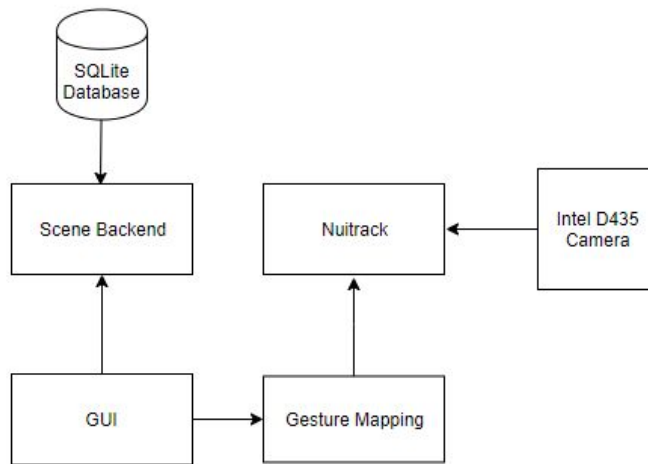


Figure 2 - Architecture Diagram

Implementation Overview

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

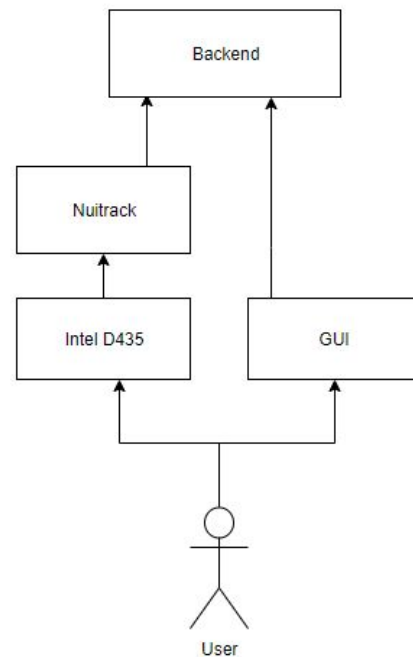


Figure 3 - System Diagram

GUI/Database

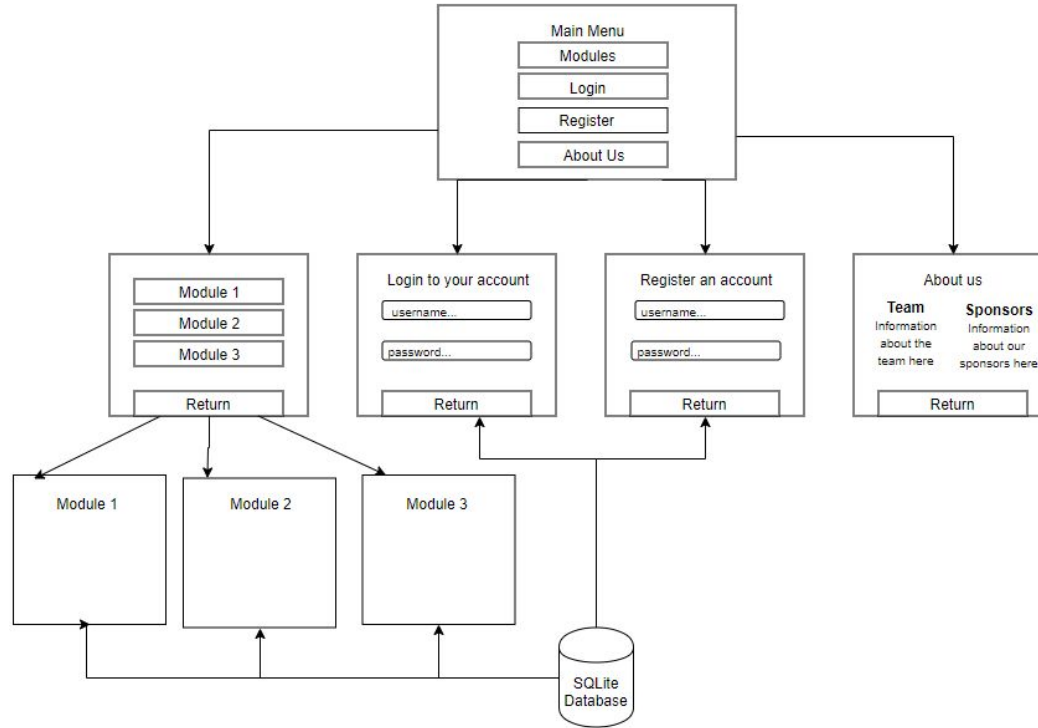
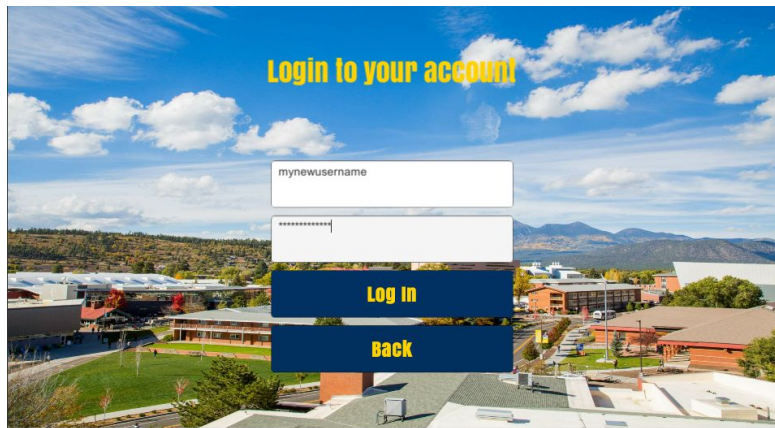


Figure 4 - Menu Layout

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



Login	
+	nameField: InputField
+	passwordField: InputField
+	errorDisplay: Text
+	submitButton: Button
-	id: int
-	Start()
-	TaskOnClick()
-	accountExists()
-	getID()
-	loadConnectionString()

Figure 5 - Login scene and backend

Gesture Mapping

- NuiTrack - full body skeletal tracking software with gesture recognition
- Hand Tracker module

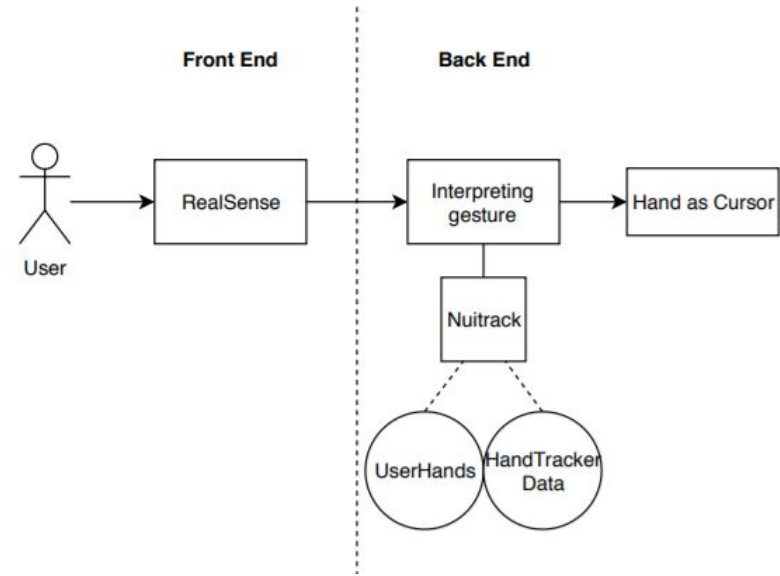


Figure 6 - Gesture Diagram

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.

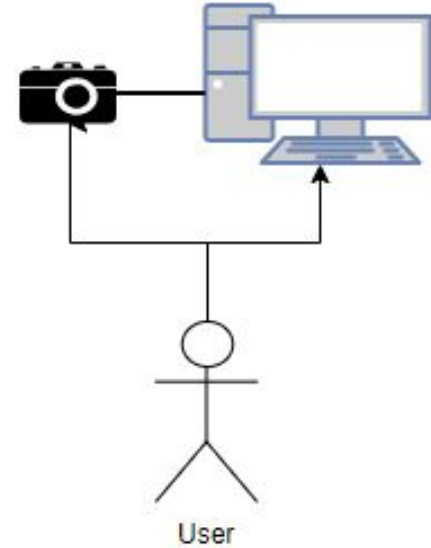


Figure 7 - Setup

Login System

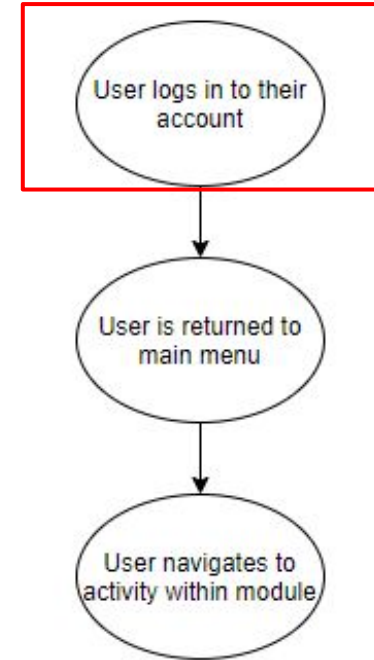
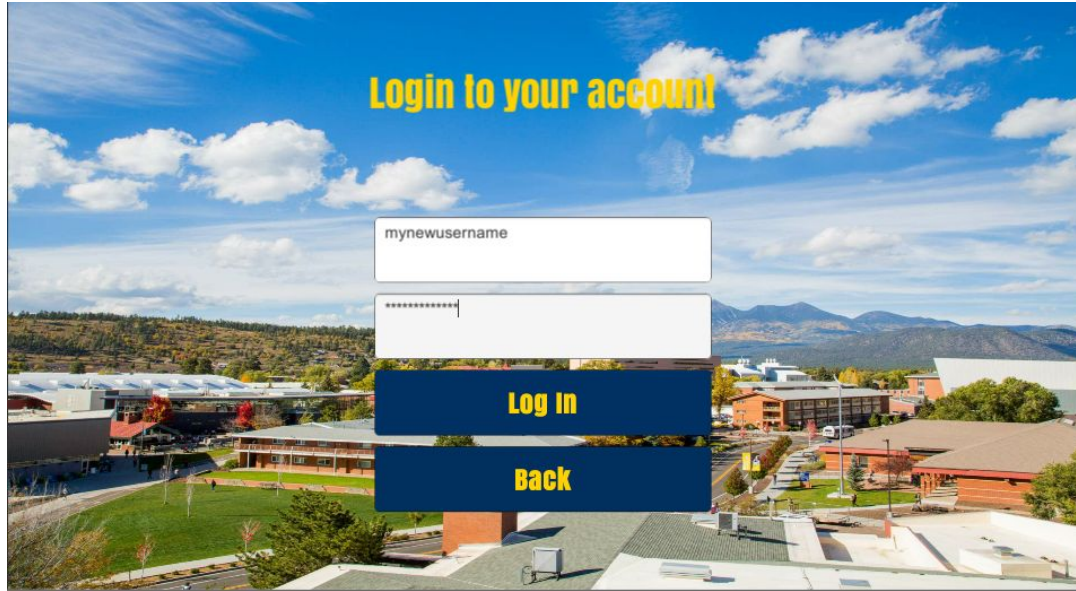


Figure 8 - Flow diagram

Login System continued...

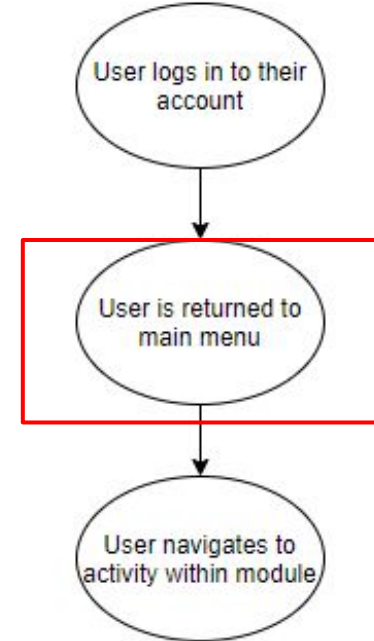


Figure 8 - Flow diagram

K-5 Module

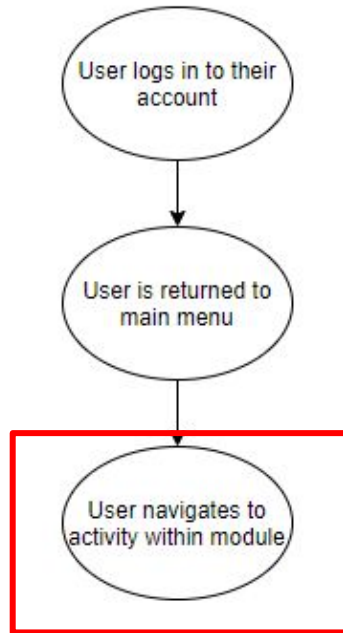


Figure 8 - Flow diagram



Community College Module

Quit Game

Job Details

Greg

Phil

Tyrone

PHIL: I have experience in Java and C++. I have 2 years of SQL experience. I am also available to move if needed.

Continue

Entry Level Software Engineer
What We Are Looking For

- MUST have a Bachelor's Degree
- 0-3 years experience
- Excellent problem solver
- Solid understanding of Object Oriented Programming
- Outstanding verbal and written communication skills
- Exposure to one of the following: Java, Javascript, C++, CSS
- Solid foundational knowledge of SQL
- Willing to relocate anywhere in the US
- Must be authorized to work in the US on a permanent basis - ability to secure

Back

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

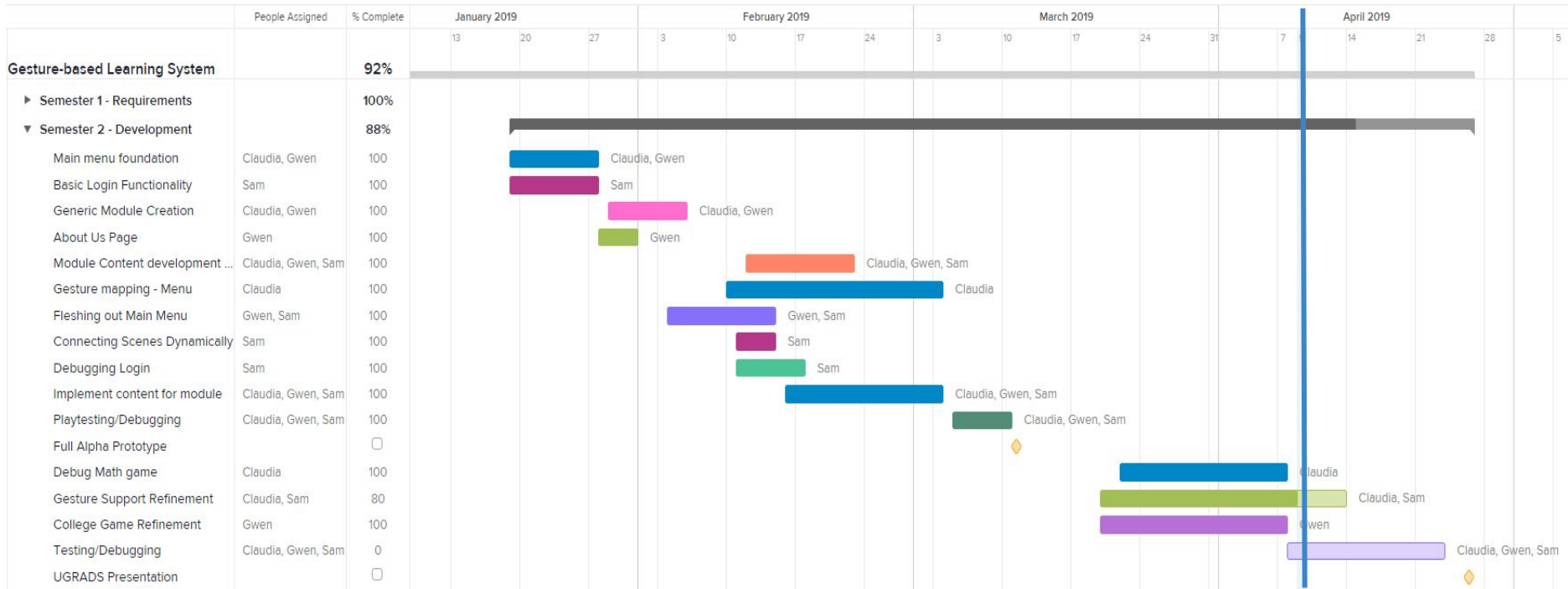


Figure 10 - Gantt Chart

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 database	User sets high score	userScore in table updated.

Usability

Purpose:	engaging and enjoyable system
Task:	Access modules and activities
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	<ul style="list-style-type: none">• 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