Requirements Document
Version 2
12/4/18
SciKids
Sponsor: Elizabeth Glass
Mentor: Austin Sanders
Samantha Earl, Claudia Coronel, Gwen Morris

Accepted as baseline requirements for the project

For Client:

Name: _____ Date: _____

For Team (team lead):

Name: _____ Date: _____

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1. Introduction

STEM is a term used to group together four areas of academic study including: science, technology, engineering and mathematics. According to the U.S. Department of Commerce, STEM occupations are growing at 17% annually while other occupations are growing at 9.8% annually. With a growing need for STEM educated individuals and the immense careers that use STEM characteristics, there is a desire for more people with interests in the field. Science, technology, engineering, and mathematics plays an important role in bettering the future for the U.S. This project involves taking resources related to STEM fields and displaying them on an inclusive platform for outreach as well as show the benefits it provides. Overall, the main purpose of this project is to encourage individuals to consider a career that involves STEM. With a student development team of Samantha Earl, Claudia Coronel, and Gwen Morris along with our mentor Austin Sanders, we plan on making gesture-based software with STEM related content. Our client, Elizabeth Glass, is the director of career development for Northern Arizona University's CEFENS college and was responsible for creating the project proposal. As mentioned earlier, this project is a gesture based engagement station for STEM recruitment and career readiness from kindergarten to college age students.

The goal for the team is to create an interactive system where students can choose and feel supported through their educational career in a STEM related field. Since there is a wide age range, there will be different modules for different age sections. Younger groups will focus more on interactive games to pique interest. This can include content like matching games to get kids moving and exposed to STEM related material. Children are normally exposed to what STEM is around the time they have already decided what they wish to pursue. Because they are already decided, it is very unlikely for them to pursue STEM even if they have discovered an interest. By exposing individuals to the benefits of STEM and aligning it with their interests the career path of STEM at an early age, it will not be overlooked. Individuals are able to make an informed decision if a STEM career is right for them. Older aged groups will include resources geared towards career development. This content will include tips for interviews and resumes. In addition, the content will provide information that older individuals will need as they search for employment and explore the interests they developed as children into a career path to follow.

2. Problem Statement

There are a multitude of STEM career opportunities in North America, and many of these positions are yet to be filled. The United States Bureau of Labor Statistics has projected a large shortage of about 1 million STEM professionals in the country. The workforce is considered an important factor in supporting United States innovative enterprise, global competitiveness, and national security, and the shortage of STEM educated workers can damage these areas. Our project would facilitate the introduction of STEM related concepts to young students and those who are considering a career change.

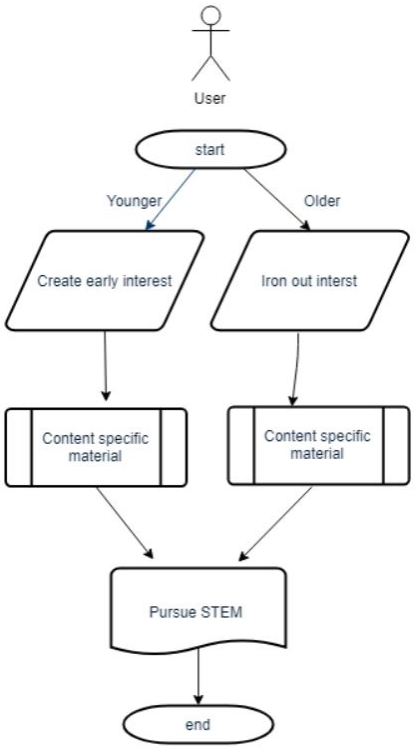

Figure 1 - Workflow

Our sponsor, Elizabeth Glass, hopes to increase STEM interest in the grade school levels. Currently, Elizabeth works for the Northern Arizona University CEFENS career department and is in charge of helping hundreds of students with career development. Elizabeth's personal desire of helping and exposing people to STEM resource led her to create this project proposal. Elizabeth's goal for this project is to create a system in Flagstaff for children, college and community members to have resources to STEM related material. The

material will be split into different areas based on age groups.The workflow we plan on achieving is shown on *Figure 1*.

An effective way of creating an initial interest in STEM is to present broad, general STEM concepts to young children in an entertaining way. Studies have shown that middle school is a pivotal time for children in deciding where their interests lie, so this age group needs to have material that can help cement student interests. By early exposure of STEM areas, we hope to begin and cultivate STEM interests which would then lead to a greater likelihood of students choosing a career in the field. Older students, such as high school and college students, need more career readiness material. This includes information on building resumes, interview skills, and achieving important standards for career readiness. Our client wants to provide a system that can solidify STEM interests in younger students and provide material that focus more heavily on career development skills for older students.

Currently in Flagstaff, there is no gesture-based learning system to provide these resources to children, college and community members. Although there is certain events that Flagstaff holds that help with student outreach, STEM City, there is no system that is ongoing for everyday use. Elizabeth's vision is for this gesture-based learning system to be used in Flagstaff classrooms and community, when available for check out in her office. We plan on making this system the first of its' kind in the community, to spark desire to pursue a career.

3. Solution Vision

The solution that the team will implement is a gesture based learning system for STEM recruitment and support in the kindergarten through college and community age individuals. A gesture based system itself is defined as a system that allows individuals to engage in a virtual environment using motions and movements that mirror real life actions. There are several benefits that the team and sponsor have identified that lead to including gestures for the project. Gesture based learning systems can increase an individual's intrinsic motivation. Gesture based systems have also been shown to increase memory retention and aid in learning concepts through physical means. By choosing to implement motions, students are able to have a virtual,

hands-on learning approach which will allow the users to actively and physically engage in their learning.

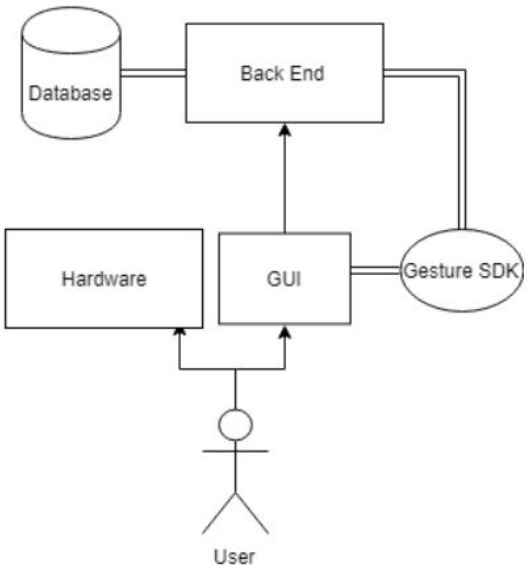

Figure 2 - Tech Interactions

Figure 2 provides a simple visual representation of how the technologies will interact with each other and the users. For the hardware, we plan on using the Intel RealSense camera to detect gestures. For the graphical user interface, we will be using features that Unity provide in building an interface. To map the gestures that the camera picks up we will be using Intel RealSense SDK. The GUI and backend code will be handled with Unity through coding in C#. The login system and database will be implemented using mySQL and PHP. They system will be composed of a series of modules targeted towards certain audiences. Inside each of these models is content to explain the concepts that students are learning. Each module will have games for content. The system will also provide a login system for the user where the content of each account is stored in a database. This project will continue to be worked on after the capstone time period. This means that the project must also accommodate other users adding new modules to this project. People will also be be capable of adding new content to the modules as our team is only responsible for a limited amount of content. The goal of this project is to have a program that will encourage interest in the STEM fields and support those who have already choose to pursue a career in this field. This solution extends the core functionality of the problem statement by:

- *Solving the problem of no gesture-based learning systems in Flagstaff*
- *Providing a mobile system that can be transported from classroom to classroom*
- *Providing STEM resources to children, college, and community members.*

4. Project Requirements

In order to develop a product that matches our solution vision, we have gathered and placed into different sections the functional, non-functional, and environmental requirements. During the process of developing the product, these requirement specifications will act as a guide in ensuring that the specific problems and solutions presented are indeed what makes our product of value to the users. Here are the domain level requirements for our product:

1. *Users will be able to gestures as a means of navigation through the system*
2. *Users will be able to access different modules through our system.*
3. *Users will be able to by making a personal profile and see personalized available modules.*
4. *Users will be able to save personal progression and set high scores.*
5. *System must be intuitive and easily extensible for future developers.*

Each of these different domains contain functional, non-functional, and environmental requirements. These domains work together to complete the overall purpose of our system. The next section in our document will be addressing these high and low-level requirements with respect to their types.

Functional Requirements

1. **System will provide a main menu for module selection**
    1.1. User can click on different modules through main menu and can swipe through pages to access other modules.
    1.2. Provide access to login button, settings, and about us information

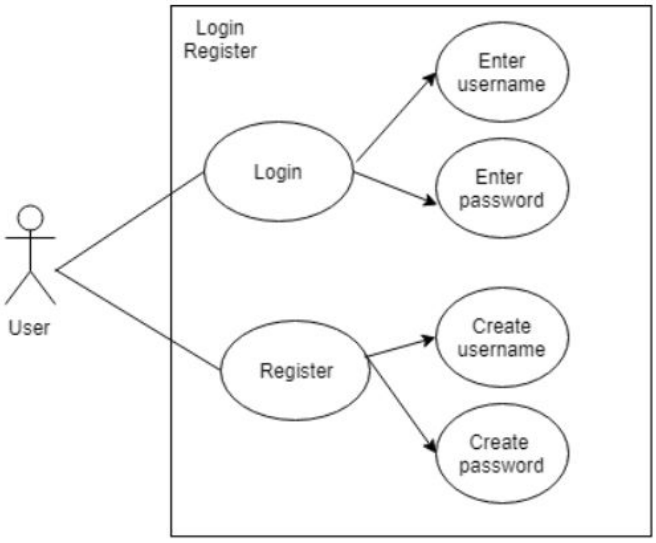

Figure 3 - Login System Use Case

2. System will have a login system (See figure 3)

2.1. System shall provide a layout for users to create an account

2.2. System shall provide a place for users to enter a email and password

2.2.1. Allow users to create a username

2.2.2. Shall allow users to login to a previously created account

2.2.2.1. System shall ask user for username and password

2.2.2.2. The system will validate the password and email given by the user

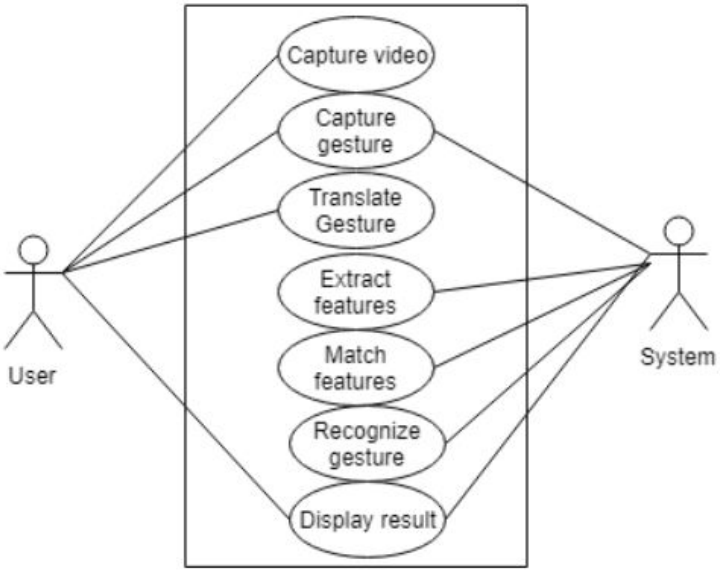

Figure 4 - Gesture-Based Use Case

3. System will use gestures for navigation and gameplay (figure 4)

3.1. System shall map certain gestures to actions that will allow the user to navigate the system

3.1.1. System shall be able to extract features, match features, recognize gestures and display appropriate results

3.1.2. The main menu will have two main gestures:

3.1.2.1. A swipe will allow the user to go to the next page.

3.1.2.2. An outstretched arm with the hand displayed palm-out will allow the user to click a button. This will be used to select modules.

3.1.3. Each module will have their own set of gestures laid.

3.2. System shall provide a tutorial for the navigational framework

3.2.1. A non-obtrusive graphic at the bottom right-hand corner of the screen will show users how to click a button or swipe to new page.

3.2.1.1. The graphics will demonstrate to the users the pre-defined gestures used in order to interact with the menu(s)

3.2.1.2. It will take up at most only 2/10 of the total screen.

3.2.2. A tutorial button will be included on the main menu.

3.3. Each activity will provide a tutorial covering gestures used in the game

3.3.1. If an activity defines new gestures other than those defined in the main menu, then the activity will include a separate button for new users to learn the gestures the activity requires. This allows experienced users to ignore the tutorial.

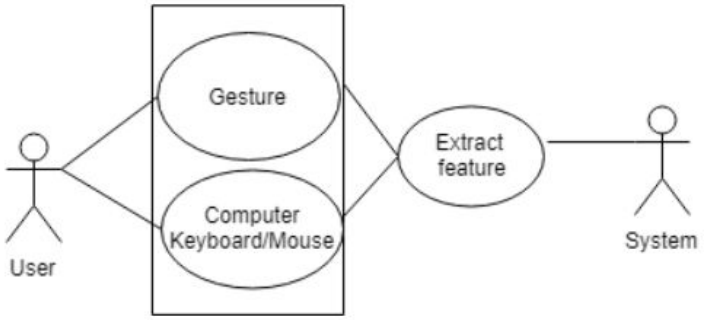

Figure 5 - Desktop to Gesture Use Case

4. **System will include a desktop version (figure 5)**
    4.1. Defined gestures will be replaced with traditional inputs through a mouse.
        4.1.1. Clicking a button will be changed from an outstretched-arm gesture to a mouse click.
        4.1.2. Swiping through pages will be replaced by a click-and-drag input.
    4.2. System needs to easily switch between using gestures and using a mouse.
        4.2.1. The program needs to recognize when a mouse input is given, and switch to reading mouse inputs in under a second.
        4.2.2. A button should appear in the upper right-hand corner that, if clicked, will allow the user to switch back to gesture-control if a mouse input triggers a switch.
5. **System software will be easy to install**
    5.1. A user with little to no programming experience needs to be able to easily download the software needed.
        5.1.1. A link will be provided that will allow a user to download an .exe installer onto the user's computer. This will then install all of the necessary files for the program.
    5.2. We plan to have our client download the software to judge the ease of setting up the system.

Performance Requirements

The performance requirements of our system are important because they judge the operation of the system, rather than specific behavior. Here we will include some of the following performance requirements we set as goals for our software:

1. **Portability**
    1.1. The hardware needs to be physically mobile. The camera must be small enough to fit in a bag and be transported from place to place. This will then install all of the necessary files for the program.
2. **Modifiability**
    2.1. The program should be modularized. Future programmers must be able to create their own content that can be quickly added to the system.

2.1.1. Code for main menu needs to have an easy way of including external programs. This includes having a function that loads in a module into the main menu.

2.1.2. System must be able to support edit of display of module or activity is in the menu.

2.2. Content already created should be modifiable for future programmers.

2.2.1. Precreated files needs to be viewable through Unity and the programmer's C# editor of choice.

3. Security

3.1. Data for profiles will be saved in a database that is not accessible users who do not have access to that database.

3.1.1. System will provide error message given incorrect combination of password and email.

3.2. Log in will require a certain number of characters, and require the use of at least one number to increase password strength

4. GUI Color Schemes and Graphics

4.1. Emotional Factor

4.1.1. The modules should invoke emotional responses from the users. This will be done through the use of colors, activity layouts, etc. Each module should be appealing towards that module's demographic.

4.1.2. We will have heavy input from our client to ensure that we properly engage the user with color palettes and graphics. User testing will also be incorporated.

4.2. Professional Factor

4.2.1. The main menu needs to incorporate the official NAU color palette.

4.2.2. The NAU logo along with the State Farm logo needs to be present in the main menu,

5. Accessibility

5.1. This project should be accessible to a wide range of people, including those with certain physical impairments.

5.1.1. The system will include voice-overs for users with vision impairments.

5.1.2. The system will include subtitles for users with hearing impairments

Environmental Requirements

Our client has left many of the technological choices to us, so we had free range on which environments to use. The only constraint is having the system compatible with Windows 10.

5. System Testing

Our client has stressed the importance of module inclusion in our minimal viable end product. This is to showcase our project to future college and community events along with advertising our product to programmers who may wish to add content to in in the future. We have decided on three primary modules that range from kindergarten to college that our client would like for us to include. Each module shall provide a brief introduction to STEM and will include one activity per module.

1. A K-5 module
    1.1. 5-10 minute activities to support attention span of a child.
    1.2. Graphics must be included and must be simple cartoons of animals, trees, etc.
2. A 6-12 module
    2.1. Activities longer than 10 minutes will have savepoints.
    2.2. Activities are focused on specific careers/majors. For example, a module can have an activity more focused on biological concepts.
3. A High school - College module
    3.1. Activities longer than 10 minutes will have savepoints.
    3.2. Information videos are added as supplemental information to activities.
    3.3. GUI and graphics need to be more professional than the younger demographics. This includes more muted colors and pastels. The colors in one activity should complement each other.

6. Potential Risks and Challenges

For our project we have identified four risks and challenges. These risks include serious negative consequences concerning software and less consequential user challenges.

6.1 SDK Discontinuation & SDK Limitations

As found with the Microsoft Kinect SDK, there is a high possibility that the SDK needed for gesture mapping is discontinued by the Intel RealSense development team. We have already seen the first Intel RealSense SDK for Windows be discontinued, but the SDK applicable for the Intel RealSense D435 is currently an open-source project on GitHub. The project is currently being continuously updated, however there are examples of other projects on GitHub that have been discontinued. There is no current indication that we can find of the Intel RealSense SDK 2.0 being discontinued in the next five months, however the team is still holding this as a possibility.

Most of the updates found on the RealSense SDK 2.0 deal with depth streams, point clouds, etc. The previous SDK offered premade prototypes to show gesture and facial recognition, but no premade prototypes dealing with gesture recognition to be found on the SDK 2.0. This is a concern for the team, as gesture recognition is one of the core elements of our project.

In the event that the chosen SDK is discontinued or if the team finds that the SDK has extreme limitations with gesture recognition, the team will look into alternative SDKs. One SDK is Nuitrack, which the website claims to offer full skeletal body tracking, gesture recognition, and facial recognition. Another alternative is Gestoos (https://gestoos.com/consumer-electronics/), however the SDK and documentation of it is not freely available online and must be requested. The worst-case scenario would be the team buying a new camera that is supported by an SDK that has not been discontinued or can better help us solve the problem at hand.

6.2 Product is Unappealing

The main goal of this project is to spark more interests in STEM careers and help people learn and maintain information in a fun and engaging setting. The risk here is that if a large amount of people find the modules boring or uncreative, users are then not engaged. This is one of our biggest hurdles, as this product is meant for a very wide demographic. The group must interview people of different age groups to see what inspires and motivates them, and then

portray those answers onto the modules. We have also been looking into other STEM related content online to see where we can draw inspiration from. Our client also actively works with kids to adults, so we are working with her to create three fun and appealing activities to showcase at the end of our capstone. However, because we are spending the most time creating the base of the product, we have a limited amount of time to create the three modules required. Because of this, interviews mentioned prior are critical to ensuring that the modules created are interesting to the users. The team plans to work very closely with our client in creating the modules using the information gathered from the interviews.

6.3 User Learning Curve

Today, many users can easily recognize an X on a program as the “close” button. Although humans use gestures in day-to-day life, using specific gestures to interact with software might serve as a little more of a challenge. There are two main sets of gesture-interaction - gestures for the main menu and gestures for different modules. The main menu should have only few necessary gestures mapped. A swipe to go to the next page and a hand out to click on a module should suffice. Users can be easily taught these gestures through a short tutorial or hand-guide.

Each module may use a seperate set of gestures. Again, our team is responsible for three modules, with one game per module and their necessary gestures. We have decided to allow future programmers to be responsible for the set of gestures they choose to use for their own content, so long as their redefined gestures lives only within their content. The navigational page(s) and other modules will not be affected. As for the modules we plan to create to showcase our product, the gestures used will be the same as the navigational tool. If any new gestures are defined, we will do the same as the navigational page(s) and provide the user a short tutorial.

6.4 Accuracy Issues

Unlike using a mouse or touchscreen to interact with a device, a camera must continuously take in images and process them for gestures that a program can interpret. Processing images includes filtering out background noise and calculating the distance between the user’s hand(s) and the camera. This puts a gesture-based system at a disadvantage to more direct devices for user interaction, as little to no filtering is needed. In an attempt to

maximize accuracy, we can tell the user how far away to stand from the camera. Programs for the Microsoft Kinect did this by warning the user when they were too close or too far away from the camera. Regular testing throughout development will also help us to increase accuracy, as we will learn how to use the camera's depth range and field of view more. Beyond this, accuracy is more dependent on the device itself rather than programs created for it.

7. Project Plan

The team is currently creating a prototype that shows basic elements of our project. This includes gesture recognition, mouse support, and a simple login system. The following Gantt chart shows what we has completed thus far.

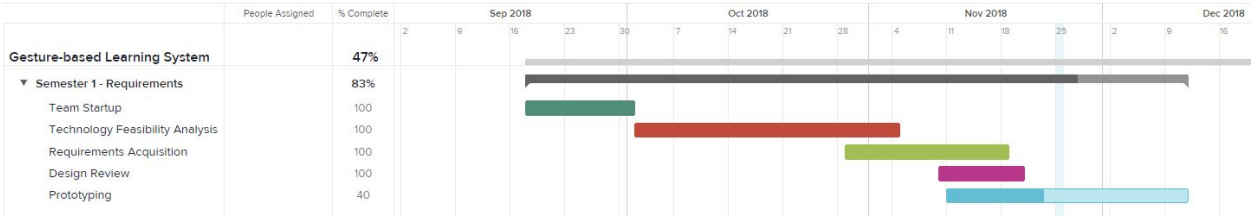

Figure 6: Requirements acquisition phase

In mid-September, the team quickly met and established team standards and member roles. We also met with our sponsor to discuss broad requirements for this project and began researching different technologies to be used for our project. Eventually, we decided to use the Intel RealSense for our hardware and the development engine Unity for backend and GUI development. The team met with our sponsor to explain our choices, which she fully supported.

In the first week of October, we began to focus on detailing system requirements, shifting from broad and abstract modules to a step-by-step case on what the system should do. Our client presented us with a flowchart of how the system should be organized. We also discussed GUI presentation and more specific modules for the 3 age groups that we were tasked with creating. The requirements acquisition phase lasted through mid-November, with the major milestone being the design review presentation.

We are currently in our prototyping phase. Once the team decided to use Unity, we all installed Unity to try and get over the initial learning curve. As of now, we have a basic desktop prototype in place. The team has linked the RealSense SDK to Unity in hopes of quickly mapping gestures to the desktop prototype.

The middle of December will marks the beginning of our development phase, which is mapped in the following Gantt chart:

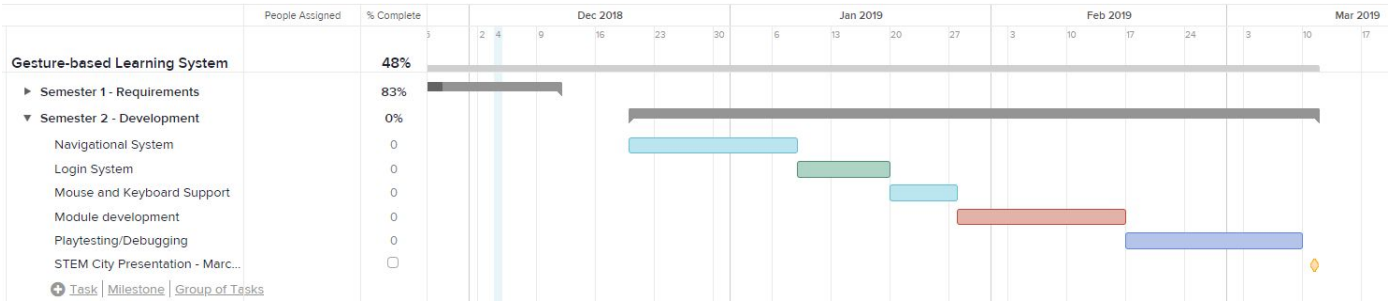

Figure 7: Development phase

We will initially focus our time into creating the core of the project. This includes creating the main menu that will allow users to navigate through different modules. This should also be modularized for future programmers to add content to after our capstone is completed. We will also be creating the login system as discussed previously. After the base is completed, we will begin creating the three modules. These modules are very important to our client, as it will allow us to fully showcase our product. After the modules are complete, we will work on playtesting them to ensure we have a minimal viable product. The group's main deadline is March 11, in which our client wants the group to present our project to the Flagstaff STEM City community event.

8. Conclusion

In conclusion, Scikids is a team that was formed with a goal to provide STEM outreach services to the Flagstaff K-12 and community individuals alongside our sponsor Elizabeth

Glass. We are in the progress of creating a gesture-based learning system that includes different modules, interactive fun, and personalization. The current problem is that STEM is a vastly growing field with not enough individuals going into it. There is also not a system in place for individuals, specifically in Flagstaff, to receive support and resources for the field. The solution in the Flagstaff community is to create this gesture-based learning system to be easily accessible and portable for K-12 college, and community members. In addition to developing the product we feature some of the risks involved. Although there are a risks, we have detailed these and provided plans to mitigate them,. Finally, by laying out the key requirements for this system we gain a full understanding of the desired end product and will continue to develop it. By agreeing to this document, we accept the specified requirements as being necessary to our new system. Currently we are in the early stages of developing this project, and we anticipate a great outcome.