Using a Pokémon Go Style Game in Introductory Computer Science Courses

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Professor Heather Marriott has been teaching at Embry-Riddle Aeronautical University for over 10 years. She teaches computer programming courses using the languages Python, MATLAB, C, and C++. Before coming to Embry-Riddle, Heather worked for ten years as a software engineer at Chemical Abstracts Service in Columbus OH. She earned her masters degree in Computer Science from The Ohio State University, where she specialized in artificial intelligence. In her spare time, Heather develops apps for mobile devices, leads the Prescott juggling club, and helps local high school students compete in NCL cybersecurity competitions.

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Abstract

The objective of this research was to see if introductory level programming students would benefit from using an interactive Pokémon Go style mobile application. Students are notorious for using their phones all the time, even during class. This research aimed to see if this could be leveraged to the instructor's advantage by introducing a mobile application that the students could use to learn computer science material. Augmented Reality was used to add to the appeal of the app and increase student interest. The free app I used for the research was developed by senior capstone students at Embry-Riddle Aeronautical University and published on the Apple App Store and Google Play Store. This game is classified as an exergame[6], as it includes a map and leverages the benefits of physical activity while learning. Areas of study included student perception of the enjoyment level of the application, the usefulness in learning and retaining the material, and suggestions for improvement. Based on the results of this research, the project should be expanded to incorporate content for other courses and possibly even other universities. An Augmented Reality Mobile application can be a supplement to traditional lecture materials and allow independent learning, which can be especially useful during a pandemic. However, my research showed that the map and augmented reality portion of the app were less highly rated and not as important as the practice mode which could be completed without walking around campus.

1 Introduction

During the best of times, computer science is thought of as difficult to instruct and to learn[1,2] and dropout rates in introductory computer science courses are high[2]. Teaching today is made even more difficult by the fact that modern students are often looking at their phones during class time. Some research suggests that students are less interested in textbook and whiteboard and instead are more motivated by content they can interact with, and games[7,9,10,12]. One mobile application I see students playing before, after, and unfortunately even during class is Pokémon Go. Pokémon Go broke records with over 250 million people downloading it per month after the initial release[5]. The Pokémon Go mobile app is arguably the highest profile app using Augmented Reality. Augmented Reality combines the user's real environment as seen through a device's camera along with superimposed images. Pokémon Go also has the notable feature of being an exergame[11], a game that rewards exercise. Statistics show that Pokémon Go players have walked over 8.7 million kilometers while playing the game.[5] Use of exergames, games that promote exercise, have been linked to positive health benefits as well as educational benefits[6,9]. Studies have linked physical exercise to positive cognitive and academic performance outcomes and suggested that all ages can benefit from physical activity in the classroom[9,12].

The use of Pokémon Go has declined some over time but the app still remains relevant with over 150 million people playing it today[5]. The Pokémon Go game utilizes Augmented Reality by superimposing images over the camera's view of the environment. Augmented Reality has been

incorporated into more and more educational applications[8] and was incorporated into this application to improve student interest. This research was conducted to see if this style of game could successfully be used to help computer science students learn their course material. Given that exercise and movement have been shown to benefit some students[6,9], the motivation for this research is to add an exercise component to the traditionally sedentary activity of computer science.

2 The App

The mobile application used was designed by senior software engineering capstone students at Embry-Riddle Aeronautical University in 2021. The capstone project was a demonstration of the ability of the students to use map functionality and augmented reality as their Software Engineering Capstone project. The application required students to visit three points of interest on the campus in order to see and interact with the augmented reality content. The augmented reality content was designed to quiz Mandarin students on 25 multiple choice vocabulary questions. Figure 1 shows screen shots of the Capstone project. The students released an app with the name Lunar Languages on the Google Play Store[16] and after they graduated, I was able to update the code and get it released on the Apple App Store[17] in May 2021.
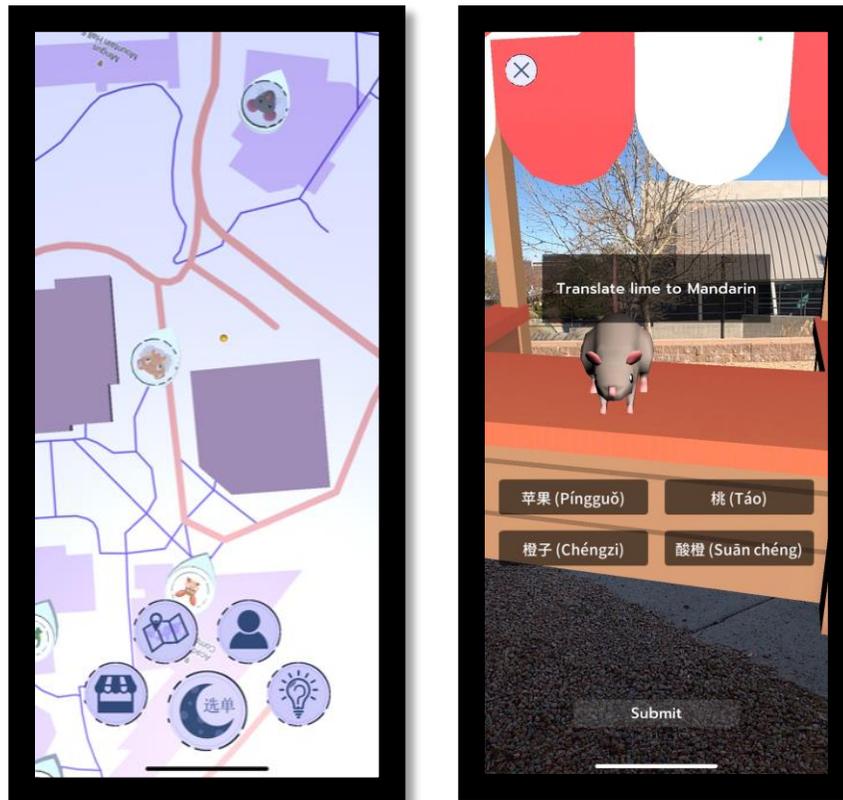

Figure 1: Screenshots from 2021 Software Engineering Capstone Project

In the summer of 2021, I expanded on the initial software project created by the students and incorporated new content into the app to include a total of 12 points of interest on campus and support for the CS118 introductory computer science course. See Figure 2 for examples after the software was updated to support computer science. The CS118 course is an introduction to computer science taught using the programming language python course primarily for freshman.

The original Lunar Languages developers have since graduated, but the question remains, would this style of application be a useful addition to course curriculum for other courses. The app has the potential to be continued and expanded if there is a positive response.
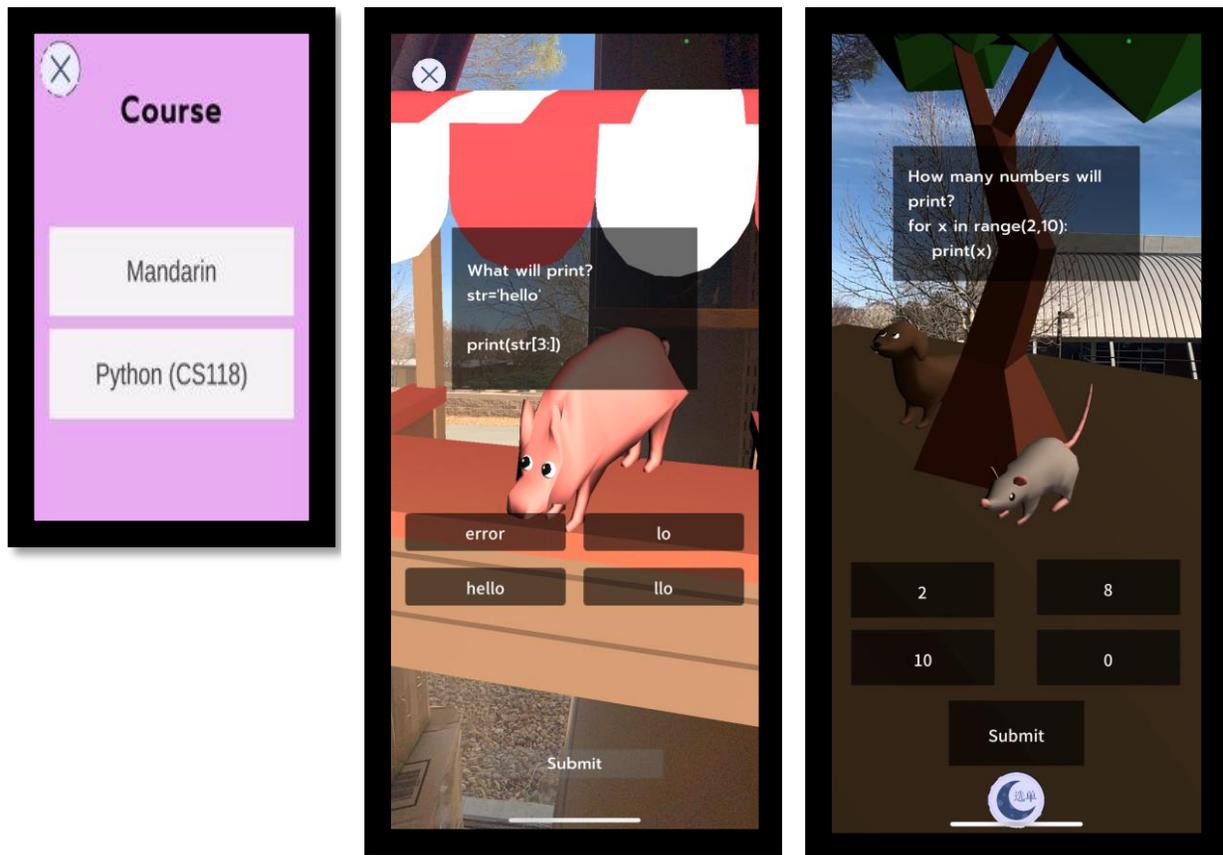

Figure 2: Updates to Lunar Lang to Support CS118 Computer Science Course

3 Augmented Reality and Practice Mode

The application supports two different courses and twelve different categories of questions per course. As student walk around campus, there were twelve buildings where they could interact with augmented reality content to answer questions. Each building contains a different subject, the same subjects that are available in practice mode: Expressions, Variables, Decisions, etc. An example of the map can be seen in Figure 1. Depending on the course selected, the same scene will show either python or Mandarin questions.

Students can select the practice mode, which can be played from any location or the map mode (Figure 1). Within each category there is the ability to add subcategories like Easy, Medium, and Hard. Once the practice subject and easy, medium, or hard level are selected, the user will be asked a series of multiple-choice questions. See Figure 3 for examples of the practice mode. The students are given immediate feedback with sound and messages after each question is answered.
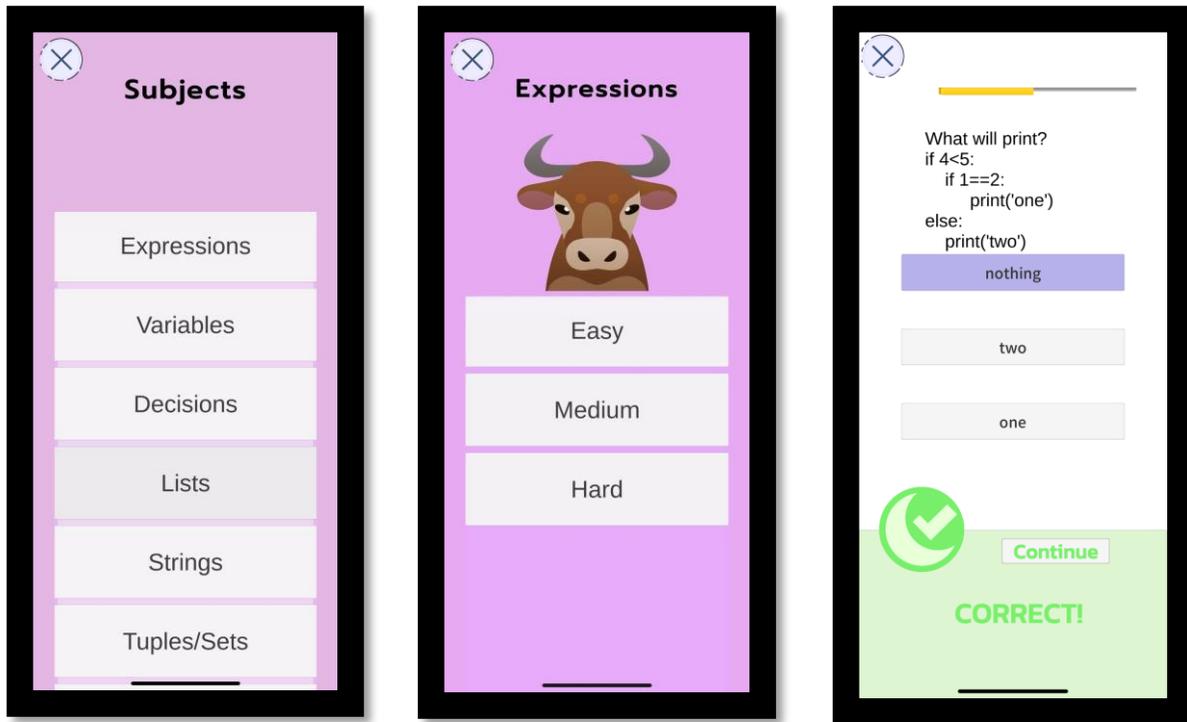
Figure 3 – Practice Mode Categories and Subcategories

4 Student's Perception of Learning and Enjoyment

The augmented reality application was introduced in three sections of CS118 in fall 2021. The students were taught how to use the mobile application and spent a class period walking around campus playing the game. At the end of the class period, students were asked to complete a survey on their experiences. A total of sixty-six students tried the app and filled out the survey at the end of class. The first question asked the student how fun they found the Lunar Lang application. Close to 40% of the students rated the game as fun or very fun, the full results for this question are shown in Figure 4.

When asked if the Lunar Lang app was helpful in learning and/or retaining the material, 73% of the students rated the app as Helpful or Very Helpful. See Figure 5 for the complete results to this survey question.

The survey asked students to rank the individual application elements: Practice Mode, Augmented Reality, Map Feature, Materials Included, Level of Questions, and Interactive Experience. When asking the users about the various aspects of the application that they found useful, each of the aspects received more favorable feedback than negative feedback. The Practice Mode received a more favorable rating than the Augmented Reality mode. Students found the interactive experience and practice mode the most useful. The results for this question of the survey are shown in Figure 6.
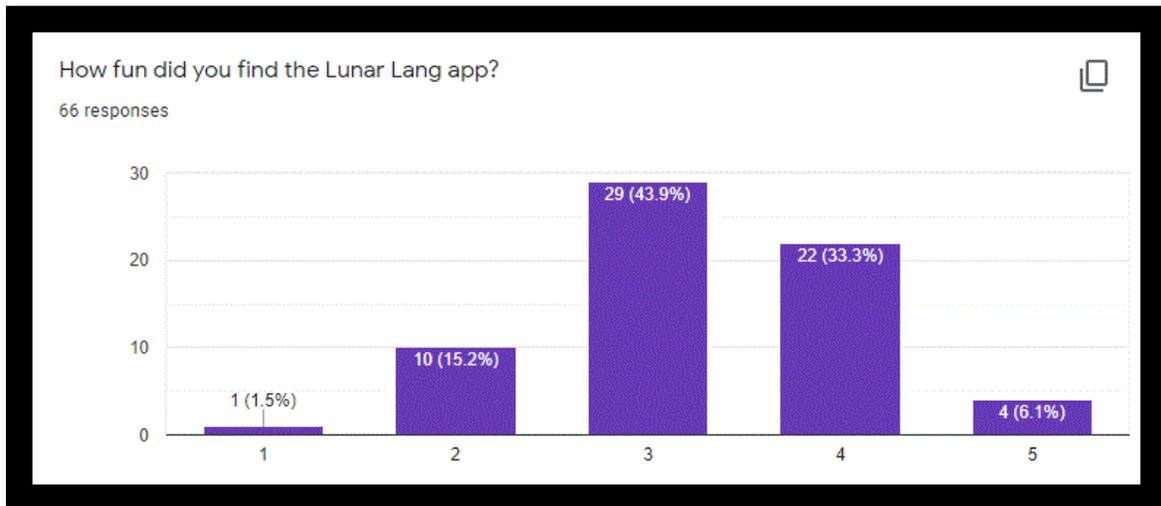
Figure 4- Ranking of Fun Using the app. (1=Not at All 5=Very Fun)
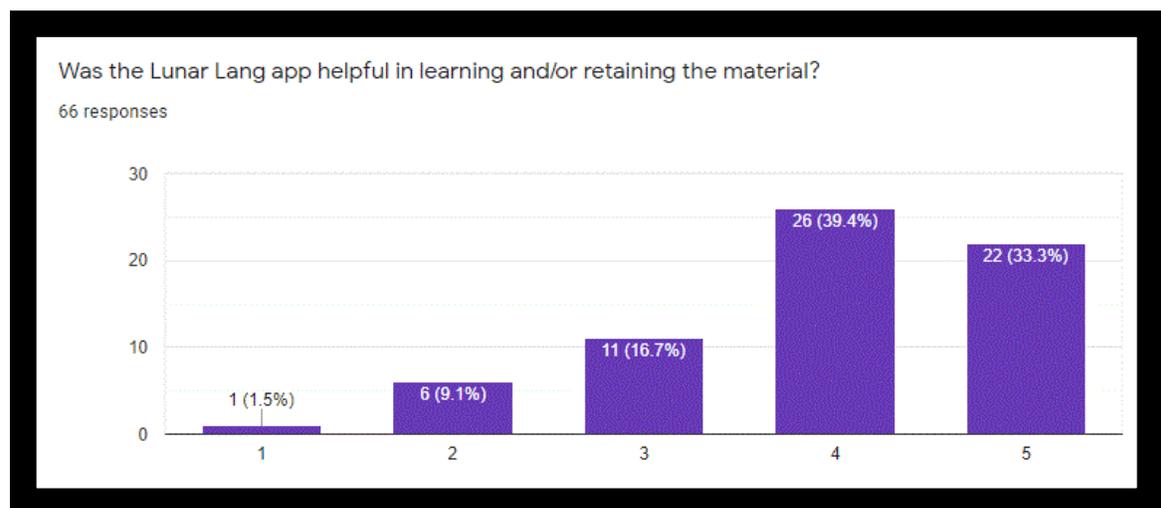

Figure 5- Ranking Learning and/or Retaining Material. (1=Not Helpful 5=Very Helpful)

I interviewed the teaching assistant for one of the CS118 sections and asked "Would this app be a useful study tool for your future students?" His answer was, "Absolutely, I like the idea behind this app a lot. Personally, I believe students can struggle with the monotony that comes with the traditional study methods (PowerPoints, textbooks, etc.) and I think this app could put them a little out of their comfort zone and thus keep them engaged". The same student teaching assistant had this to say about the gamification in the classroom "I think they(students) respond well to gamification of course material because they find it to be a more entertaining way to study than the traditional methods of PowerPoints, textbooks, etc. I think students like the gamification of course materials because it is an easy way to incorporate their friends into study sessions, which they often try to do anyway by forming study groups. "
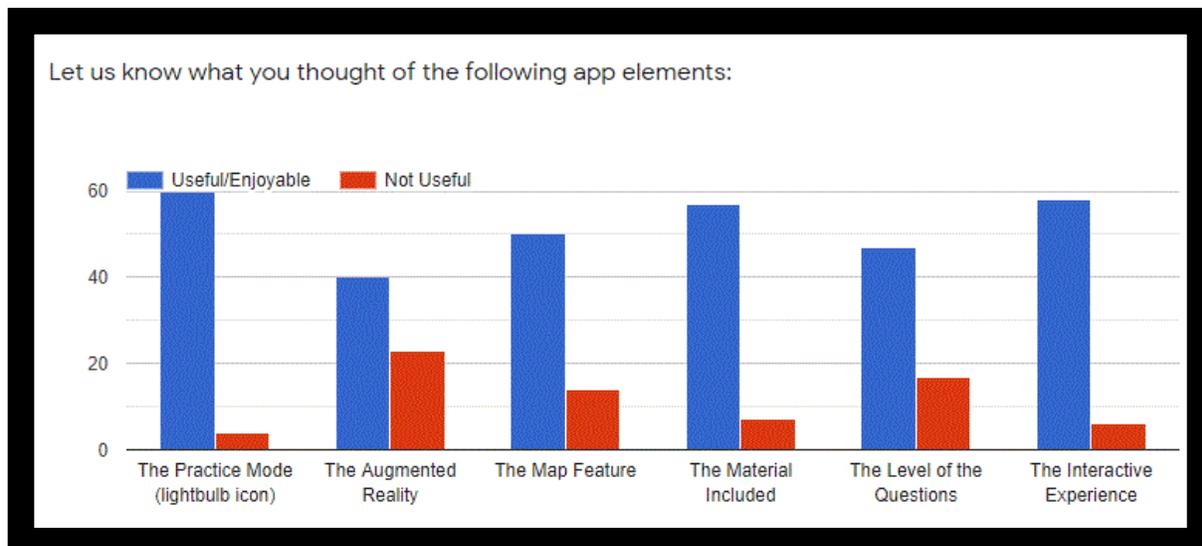
Figure 6 - Individual App Features

There was an open-ended short answer question at the end of the survey, see Figure 7, asking users to "Enter any suggestions for improving the app". A few of the notable survey answers gave suggestions for improved map functionality, pointed out score keeping errors, errors on Android devices, and made suggestions like the ability to "catch" the Augmented Reality animals. Some students gave favorable responses that indicated the app would help them prepare for exams:

Figure 7 – Open ended survey question

"I enjoyed this app as it would help allow me to better prepare for exams and learn and better understand python"

"This app is great!! The only problem I see is that the map is upside down which causes the tilting to be inverted. I can't wait to see what this app turns into!!"

Some students did not enjoy the map feature and each time the app was introduced to a class, there were a couple students that decided not to walk around campus while trying out the app. Instead they tested only features they could test while remaining in their seats and not leaving the classroom. One student included this comment about the map aspect of the game, "This app is an educational focused learning center. I would prefer to go without the map aspects and such. Either I wish to learn something, and the map features extend the time it takes to learn that, or I think it's a game, only to be disappointed by its educational nature."

4 Quiz Grade Evaluation

There were seven quizzes given over the period of the semester. As the semester progresses, a number of students historically end up skipping more classes and sometimes dropping the course. Grades from students that started the semester but dropped the course are not included in the resulting graph. Quiz grades of zero due to non-attendance are not included in the resulting graph. The augmented reality app was introduced to the classes before Quiz 6. Using the augmented reality, map focused application to study for the quiz did not appear to impact the student grades in a noticeable way. The quiz grades observed matched what I see most semesters, at the beginning of the semester the student class attendance and engagement in the course is high. As the semester continues, some students stop attending, stop turning in homework, and stop studying the material.

The app could have been introduced earlier in the semester to see if it was a tool to keep engagement high throughout the semester.
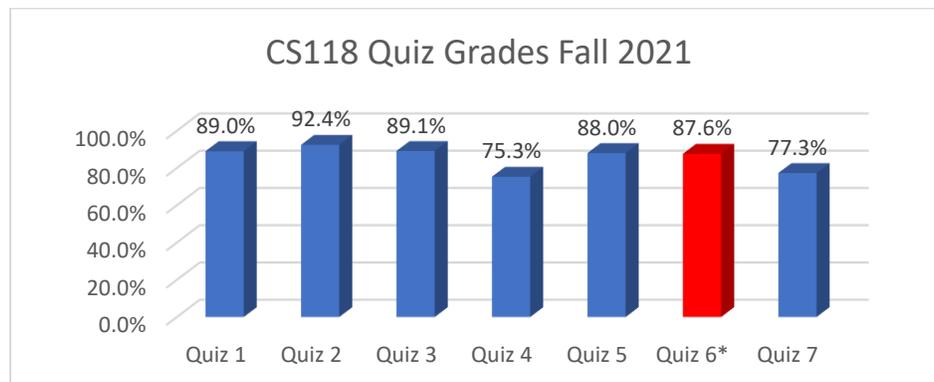

Figure 8 – Average Quiz Grades (Quiz 6 was after AR App Introduction)

5 Conclusion

Overall, the app received very favorable feedback. Each of the six main project aspects: Practice Mode, Augmented Reality, Map Feature, Material, Level of Questions, and Interactive Experience all had more students rate them as useful/enjoyable than those who rated them as not

useful. The application received internal university recognition as a great example of students teaching other students (a student capstone project being used as an instructional tool).

Based on observations of the class quiz grades and survey results, the map and Augmented Reality features did not seem as important as the bank of practice questions. Even though Augmented Reality and Exergames[6] have publications supporting their use, for this particular class, CS118, the augmented reality and map features did not appear to add much in the way of educational or enjoyment value to the average student in the class.

6 Future Work

A few senior students have already selected to continue updating the Lunar Languages app in a directed study software engineering course on mobile application development CS399. These students are in the process of address the issues mentioned in student feedback and expanding upon the offered content. I will continue to introduce the app to my CS118 classes as an optional tool they can use to study python programming. In the future we would like to allow for customization of points of interest so the game will be more useful to students that are not presently on the Embry-Riddle Aeronautical University Prescott campus.

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