

ABSTRACT

Virtual reality (VR) and gamification are growing concepts that have resulted in the increase of college student motivation, engagement, and educational performance. I will combine gamification and VR to develop a module, a self-contained unit of an intro CS topic. Using the module, I'll test whether these concepts improve the academic performance of students taking introductory CS courses.

INTRODUCTION, MOTIVATION, AND BACKGROUND

It is often noted that students who stem from other disciplines or have had minimal exposure to the course material usually have more difficulty with computer science and engineering classes [1]. Research focused on virtual reality has proposed the use of gamification in virtual reality applications to improve the academic performance of computer science and engineering students.

- Gamification - application of game-like elements to non-gaming activities which encourage users to participate and achieve specific goals.
- Virtual Reality (VR) - a computer-generated simulation that can be interacted with using special electronic equipment.

Existing research of Villagrasa et al. [4] [3] and Stigall et al. [2] indicated that VR and gamification showed an increase in students' motivation to understand course content and improve their academic performance. For my research I want to test the effects gamification and VR have on academic performance, examine a singular intro to CS topic, improve upon the statistical data of existing research, and build upon their findings.

QUESTION

Will combining VR and gamification techniques further intro to CS students' understanding of Lists/Arrays?

METHOD

My approach for answering my research question:

- 1 Select an intro to CS topic to focus on
- 2 Decide upon the VR hardware and software
- 3 Submit a Student Research Grant Proposal
- 4 Create a design for the module
- 5 Create a VR List/Array module in Unity
- 6 Create a survey/test to evaluate participants
- 7 Implement the module in CS intro classes
- 8 Analyze the data collected

MODULE

I examined Union College's Intro to CS survey data, which was collected over the last three academic years from 194 anonymous participants who rated their understanding of select CS topics (1 not much - 5 a lot).

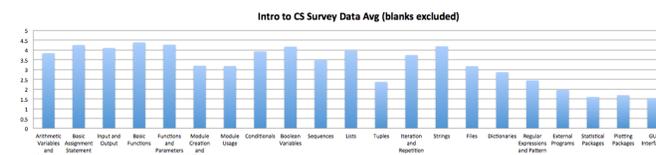


FIGURE 1: Intro to CS Survey Data distribution of averages

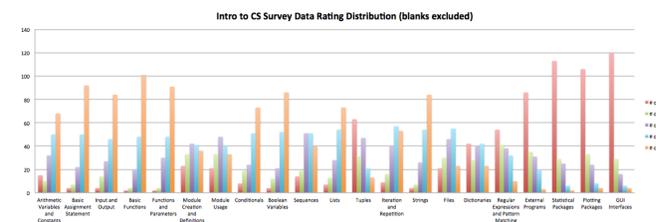


FIGURE 2: Intro to CS Survey Data distribution of topic ratings

The survey did not include many topics that I found fundamental to the intro CS curriculum so I extended the topics up for consideration to include additional concepts.

- Loops, Conditionals, Binary Numbers and ASCII, Lists/Arrays, Strings, Recursion, Files, Dictionaries, and Regular Expressions and Pattern Matching.

After developing preliminary designs of various topics from the list above, Lists/Arrays was ultimately selected for the creation of my module.

EQUIPMENT

My research will require the following equipment:

- VR Hardware - Oculus Rift VR Gaming System
- VR Software - Unity
- A compatible workstation and testing area



FIGURE 3: Oculus Rift headset, controllers, and sensors

ANALYSIS

The following list details my plans to analyze and evaluate my module after its completion:

- Administer a test/survey to intro CS students and module participants in the beginning of spring term, after they've learned about Lists/Arrays, and after using my module. For example:
 - Collect information on their current understanding of CS
 - Have they taken CS courses before entering college?
 - Do they know what Lists/Arrays are?
 - Can they solve a few problems that extend the concepts covered by my module?
- Tests may be administered between courses and will be used to compare the students that will use my VR module against the students that did not
- Monitor each participant's use of my module (i.e. how long did they use the module, how many levels did they complete, any feedback, etc.)

VIRTUAL REALITY

In my proposed design, the module implements a grocery oriented storyline in which the user is tasked to stock the shelves (add elements to the array), restock shelves when customers buy items (items are removed from the array), read a code description that details the customers behavior throughout the day, etc. A VR model can:

- Create a visual representation of elements
- Provide immediate feedback
- Depict a storyline to create familiarity
- Provide a game like initiative to the user
- Use inherently learned concepts that the user understands (e.g. spatial properties)
- Visually show known qualities of lists such as how items are ordered in an array, the size of an array, and the action of adding/removing items from an array
- Provide a more engaging and tactile approach to hardcoded qualities of arrays/lists

FUTURE WORK

As future work, I hope to complete the following:

- Incorporate audio/narration
- Repeatedly encourage participants to think out loud
- More than one level incorporating negative indexing
- Incorporate more activities in each level
- Have more variation in customers
- Implement the module closer to when the participants first learn about Lists

REFERENCES

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- [2] STIGALL, J., AND SHARMA, S. Virtual reality instructional modules for introductory programming courses. In *2017 IEEE Integrated STEM Education Conference (ISEC)* (March 2017), pp. 34-42.
- [3] VILLAGRASA, S., AND DURAN, J. Gamification for learning 3d computer graphics arts. In *Proceedings of the First International Conference on Technological Ecosystems for Enhancing Multiculturality* (New York, NY, USA, 2013), TEEM '13, ACM, pp. 429-433.
- [4] VILLAGRASA, S., FONSECA, D., AND DURÁN, J. Teaching case: Applying gamification techniques and virtual reality for learning building engineering 3d arts. In *Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality* (New York, NY, USA, 2014), TEEM '14, ACM, pp. 171-177.