The Efficacy of Augmented Reality in the Classroom

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Abstract

My senior year capstone project consists of an application utilizing augmented reality (AR) in teaching students the processes of photosynthesis. I will use the application I've built to run experiments, measure student learning through pre- and post-tests, and determine the usefulness of AR in the classroom when compared to more conventional learning methods.

Introduction, Motivation, and Background

Regardless of the subject matter being taught, some educators are striving for new and innovative methods of teaching their students. Augmented Reality is a relatively new technology that utilizes a device's camera to overlay digital images onto the screen as though they exist in the real world (see Fig. 1).

Functionality of AR:

- Overlay digital images onto camera view
- Simulate as though objects exist in real world
- Allow user to interact with simulated objects

Figure 1: Examples of AR applications today [3].

There are studies detailing that as students are more engaged in their work and the material that they are learning in the classroom, they are more likely to perform well in those courses. Stemming from this, I reasoned that using AR in the classroom will make students more eager to learn when presented with a new technology as a vessel for new information.

Question

What is the efficacy of augmented reality within a classroom environment?

Methods

Focus Areas:

- Broad inputs / outputs of photosynthesis
- The Calvin Cycle
- The Thylakoid Stacks / Grana

Visible Elements by Zoom Level:

Outer View

- Sunlight, Water, Carbon Dioxide

Chloroplast View

- ATP, ADP, NADP, NADPH

Most Zoomed View

- Carbons, Calvin Cycle Processes, Grana Processes

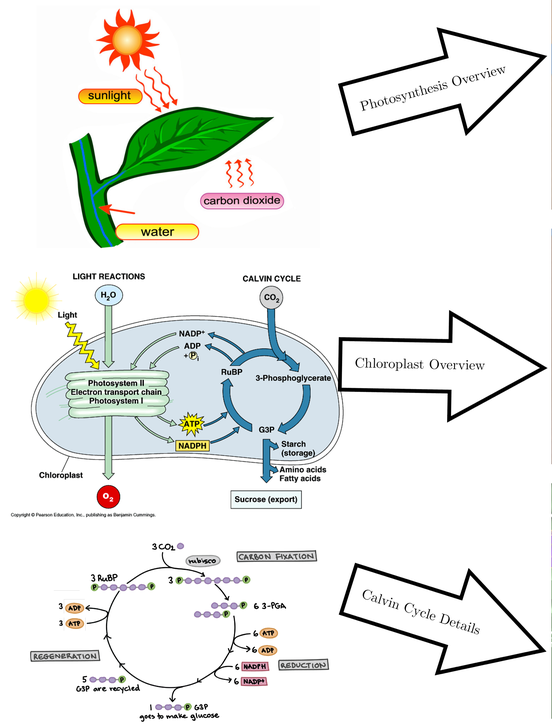

Figure 2: Diagrams of each photosynthetic process to be represented within my application[5, 1, 4].

User Experience

When using the app, the user can zoom in and out by moving the device, as though their camera is a magnifying glass through which you can see inside a plant's cells. As the user zooms closer from the outer view (Fig. 3, top), the plant disappears revealing the chloroplast (Fig. 3, middle). From there, the user can move the camera even closer to get a better view of certain processes within the organelle (Fig. 3, bottom).

Software Used:

- Unity for iOS
- Apple ARKit
- Xcode

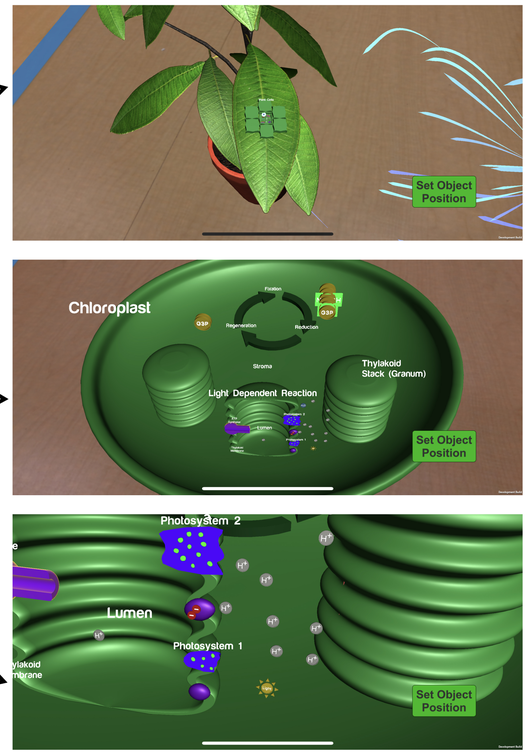

Figure 3: Screenshots of app in use, from three levels of zoom.

Experiment Design

In my study I administered both pre- and post-test quizzes, with a study period in between. Additionally, the subjects I gathered for my study were all enrolled in the introductory-level biology course at the time. Following the pre-test questionnaire, I randomly assigned the students access to either a photosynthesis cheat sheet, or both the sheet and my application. Then allowed them as much time as needed to feel comfortable about the information they absorbed from reading or exploring the items they are presented with. Finally, I had them fill out a quiz in order to gauge how much was retained from the study period.

Results

When looking at the results, I focused mainly on three aspects of the study, seen below:

Measurement	Favors	Statistically Significant?
Score Improvement	Non-AR	No
Study Time Allocation	AR	Yes
Test Time Decrease	AR	No

As described in this table, although two out of the three aspects suggested data in favor of using AR, only the Study Time Allocation was significant - which only speaks towards the technology being engaging. While I was hoping to display results along these lines, due to the fact that I was only able to recruit 10 study subjects, I believe that for the most part, my results are inconclusive with such a small sample size.

References

[1] Cummings, B.
Pearson education.

[2] Taiz, and Zeiger.
Wikimedia commons.

[3] Templeman, M.
Virtual and augmented reality marketing strategies for the coming decade, 2017.

[4] Various.
Khan academy.

[5] Various.
Photosynthesiseducation.com.