Polycommit: Forming Habits Through Gamification

ABSTRACT

Educational software is infamous for being difficult to use and not engaging. With *Polycommit*, we demonstrate that through gamification and by learning from user behavior, we can create educational software that improves retention of course content and improves test scores.

Using learning techniques such as spaced repetition and variable rewards scheduling, we created a learning platform that is engaging and compelling for users to use. We took favorite features from existing learning platforms such as Duolingo and Memrise, and refined the app's design based on feedback and data from users. Overall, we show that with polish and care shown to the user's motivations, we can create an engaging educational app that students will actually want to use, and enjoy using.

We developed *Polycommit* for use with several Cal Poly classes. We worked directly with teachers to create questions that drilled down into specific class concepts. We tested the app in 4 different classes, with 130 students signed up. We found that students who used the application performed better on the midterm. We also found that students overall had a positive experience while using the application.

KEYWORDS

Education, Gamification

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1 INTRODUCTION

Learning technology has a large problem with usability and engagement. Learning technology typically has poor UI that leads to student confusion and low rates of engagement. In addition, it does not use modern approaches to how we understand learning and motivation.

In this paper, we introduce *Commit*, a novel web-based application that uses spaced repitition and gamification elements to educational courses. For this thesis, *Commit* was deployed to a variety of classes at California Polytechnic State University to measure its effect on student engagement and learning.

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1.1 Why College Classes?

Polycommit was tested with classes at California Polytechnic State University to facilitate the creation of questions and evaluation of the application. While the app would work with any level of education from K-12 to higher education, using Cal Poly classes allowed us to easily create questions for classes whose subject matter we were familiar with.

1.2 Spaced Repitition

One of the key aspects of Commit is its use of spaced repitition. Spaced repitition is an idea first brought into the mainstream by Pimsleur in the 1960s. Spaced repitition is a learning technique where students reinforce learned knowledge at specific intervals, improving long-term retention and recall ability.

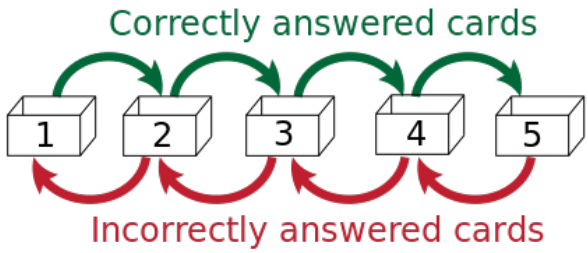

Figure 1: The Leitner system. If a student answers a flashcard correctly, it is moved to a higher-numbered box that is reviewed less frequently.

A simple example of spaced repitition is known as the Leitner system. Flashcards are organized into numbered boxes. (See **Figure 1**). Each successive box is reviewed less frequently. That is, a student would review Box 1 twice per day, Box 2 once per day, Box 3 every 2 days, and so on. If a card is answered correctly, it is moved to a box that is reviewed less frequently. However, if the student answers incorreclty, the card is moved to a box that is reviewed more frequently.

Thus, tougher cards are reviewed more often, and cards the student knows will be reviewed less often. However, all cards are *eventually* reviewed, and even cards that the student always answers correctly are reviewed in the long term.

There is strong evidence that this idea of "spaced repitition" enhances long-term memory and deepens understanding of subject material. [**?**]

1.3 Spaced Repitition Apps

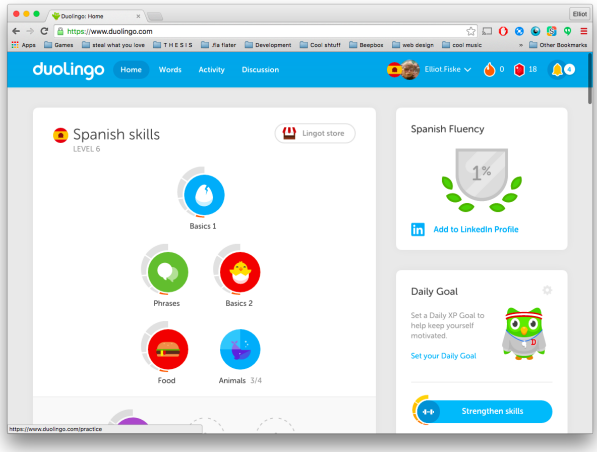

Figure 2: The Duolingo interface. Notice the gamification elements and the encouragement to reach a "daily goal."

1.3.1 Duolingo. Several recent apps and products make use of spaced repitition to allow user to easily gain long-term recall of languages, class content, or any other information that needs to be learned. One such app is Duolingo (See **Figure 2**); in Duolingo, users learn a language by repeating small tasks every day.

The app encourages users to spend a small amount of time each day studying useful words and phrases, rather than cramming in a lot of knowledge at once. It encourages this behavior through the use of gamification. Each user earns "experience" in a language, eventually leveling up. Users connect their Facebook accounts and can see their friends' levels and accomplishments, adding a social element to the app.

1.3.2 Memrise. Memrise (See **Figure 3**)is a web app that has very similar function to *Commit.* Memrise takes a series of flashcard-based questions and answers and automatically creates a "study plan" where the application breaks up flash cards and uses spaced repitition to encode the information in the user's long-term memory. Memrise also uses gamification and social elements, as users earn points for every correct answer and can see their friends' scores.

Interesting to note is that users can input any data they choose into Memrise to receive a custom study-guide. This would allow students to easily learn flashcards if they took the time to input them into the app.

Both of these applications heavily emphasize language learning, since the process of learning a language can easily be broken down into a series of small words and phrases, and re-emphasized using the process of spaced repitition. However, Commit is scoped specifically to one class, allowing students to easily learn and retain class content without the commitment of adding their own flashcards.

1.4 Gamification

The *Commit* app is structured to incentivize students to enjoy using it. The primary incentive for experimental participants was the chance at winning a $20 Amazon gift card. However, in order to actually obtain this reward the participants would have to engage with the app's systems.

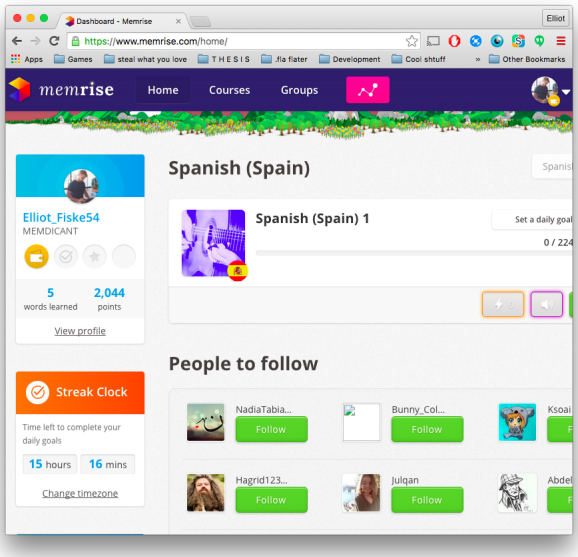

Figure 3: Screenshot of the Memrise interface. Note the gamification elements, the social aspect, and the "Streak" clock encouraging consistent use of the app.

Related Work

2 HABIT FORMATION

2.1 Habit Formation and User Interface

Previous work has been done to tie habit formation with online user interfaces [?]. In this book, Dr. Jeff Johnson describes how psychology ties into user interface design. He cites that familiar user interfaces lead to less mental stress, encouraging users to come back to your application repeatedly since it seems familiar and less stressful to them. We desire users to consistently use our application every day, so we must keep this in mind.

2.2 Memrise

As mentioned before, Memrise is an excellent example of habit formation. In one paper, researchers gauged the ability of students to memorise simple Latin phrases in a classroom setting. They found that Memrise is an effective tool

2.3 Gamification

Gamification in the classroom has several other examples that can be compared to our application.

2.4 Classcraft

Classcraft is an intriguing example of gamification in education (See **Figure 4**). In Classcraft, students choose a "role" and go on the equivalent of a World of Warcraft raid with their fellow classmates. Classcraft is interesting in that it promotes co-operation and a variety of skills, so that students can assist each other where they might not have a certain skill.

Classcraft takes the typical elements of an RPG and converts them into an experience that supplements a typical classroom experience.

Figure 4: Classcraft user interface. Note the student's health and mana pool, as well as the list of other students in the classroom.

[?]

Interesting to note is the emphasis Classcraft puts on integration with existing technologies such as Google Classroom. In order for this application to be widely adopted, it is definitely necessary to have the experience of the teacher go extremely smoothly. Thus, if an application ties directly in with existing technology that the teacher is already familiar with, it will be much more readily adopted by the educational community. It's important to value the teacher's time with this application, so it is necessary to make the UI recognizable, familiar and easy to work with, as well as integrating it with existing tools and perhaps even modeling the user interface after tools that many teachers will already be familiar with.

3 EXPERIMENT

An experiment was carried out at California Polytechnic State University to test the efficacy of habit-based educational software. We created a web-based application called *Polycommit* that we connected to 4 college classes: **Introduction to Computer Networks**, **Introduction to Computer Graphics**, **Introduction to Computer Networks**, **Introduction to Operating Systems**, and **Linear Analysis I**. These classes were selected because they generally had subject matter that was easy to convert into online quizzes. For instance, one staple Linear Analysis problem is to find the determinant of a matrix, which is easy to input into an online form.

We presented Polycommit to each of the courses in the first 2 weeks of class. Students voluntarily sign up through a website hosted at https://polycommit.com/, where they can log in with one click through the main Cal Poly portal. This lets students easily access the website, while also guaranteeing that only Cal Poly students can sign up for the program.

3.1 UI Overview

Upon logging in, students click "Enroll" for the classes they wish to participate in. After enrolling, students can begin answering questions. There are two main "scores" that students earn by answering questions: **Commitment** and **Points**.

Commitment is a numerical value that represents how many *unique* days a student has answered a question on the website. Students can earn up to 1% extra credit on their final grade in the class by getting 15 Commitment.

Points are earned by answering questions. More points are awarded for correct answers, and bonus points are awarded based on the user's current Commitment. All participants in the experiment were placed in a raffle for $20 Amazon gift cards. Additional entries into the raffle were awarded by earning more points.

4 RESULTS

The experiment was carried out across the first half of the Spring 2017 quarter at Cal Poly. 130 students signed up across 4 classes. By the end of the experiment, just over 3200 answers had been submitted to the application.

Currently, we only have access to exam data from Introduction to Operating Systems. The exams were held completely through an online quiz form, making it easy to analyze the resulting data. Data collection for the rest of the classes is ongoing.

4.1 Limitations

Certain restrictions were necessary in order to run this experiment. Most importantly, according to Cal Poly's human research regulations, studies about educational tools must be offered to all participants in a class. Thus, there was no true "control group" since any student could opt-in or opt-out of using the application.

4.2 Overall Data

First, consider the relationship between a student's overall score on the midterm and their Commitment (**Figure 6**). No student that actively used the app (more than 10 Commitment) got less than 30/50 as a final score. This supports the idea that students benefit from consistent repetition over a longer period of time.

Next, consider the mean of all midterm scores between students that didn't answer *any* questions vs. the ones that did. Students that didn't answer any questions in the app scored slightly higher on average than the students that didn't.

	Users	Non-users
Midterm Average	39.37	36.27
Population Size	43	21

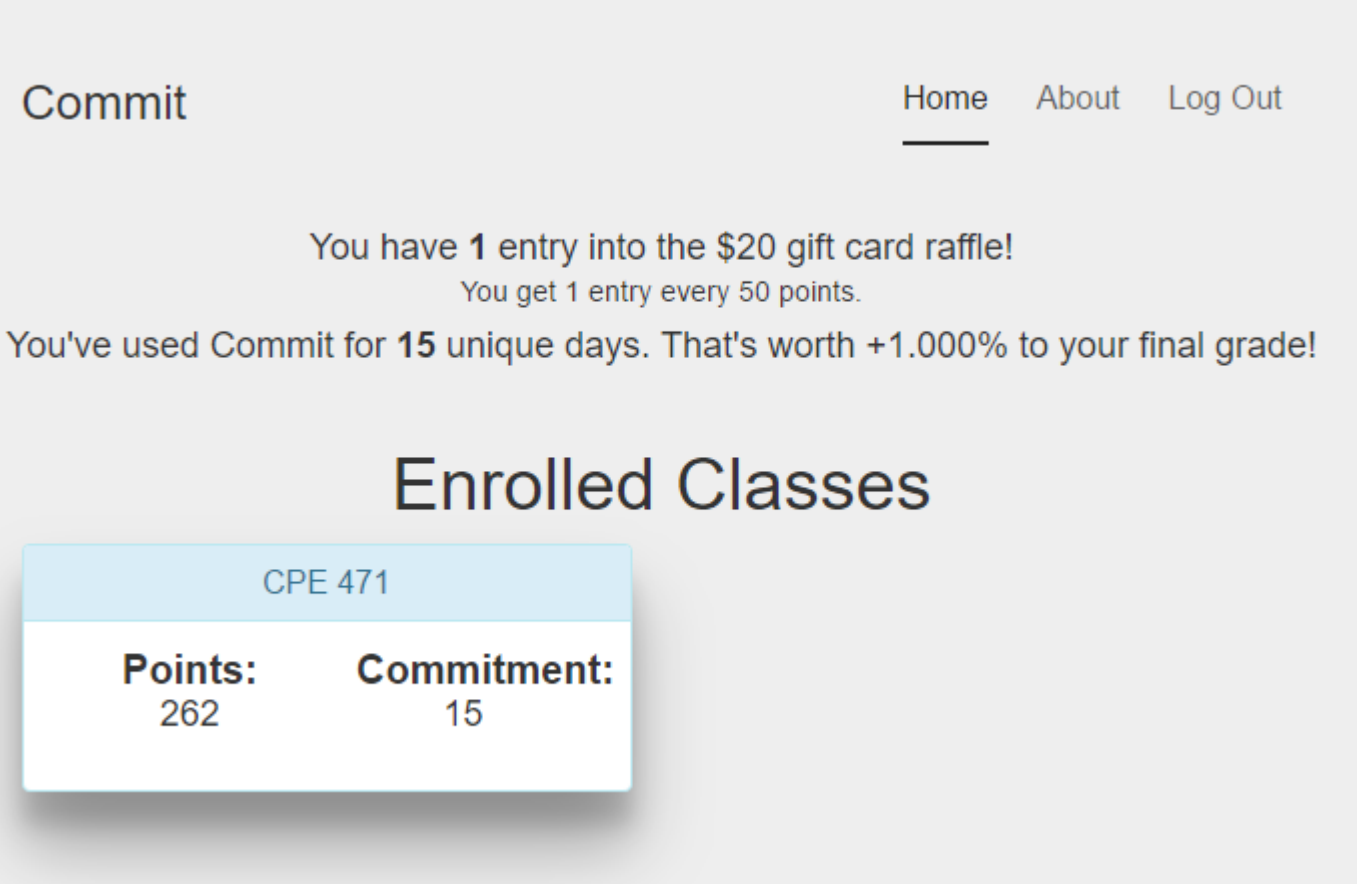

Figure 5: The "Home" screen for Polycommit. Students can see their current progress and can click on a course to answer challenges.

4.3 Individual Questions

Certain questions on the midterm matched closely with the content of the questions that were repeated on Polycommit. We can match scores

5 CONCLUSION AND FUTURE WORK

After we have collected the data from the remaining classes, we can get a more in-depth understanding of how using *Polycommit* affected student understanding of the course material and test scores.

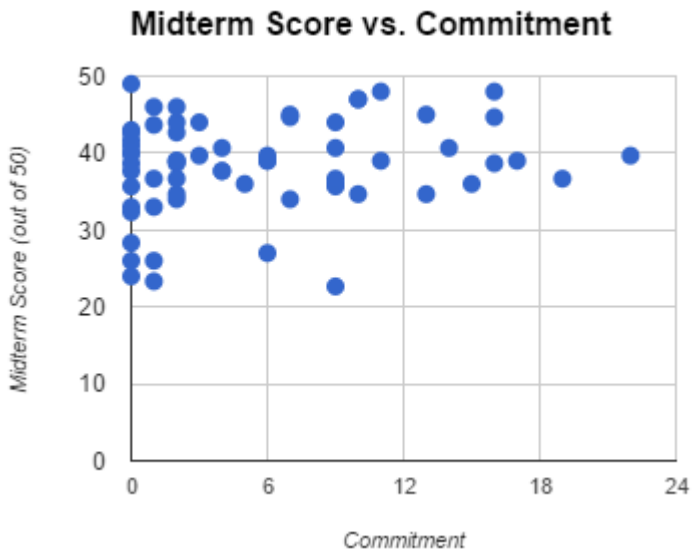

Figure 6: Graph of Commitment versus the student's score on the midterm.