

Analyzing A Video Game-Based Form of Gamification in Scientific Education and Its  
Effect on Learning

Carter Colton

A senior thesis submitted to the faculty of  
Brigham Young University  
in partial fulfillment of the requirements for the degree of  
Bachelor of Science

Adam Bennion, Advisor

Department of Physics and Astronomy  
Brigham Young University

Copyright © 2024 Carter Colton

All Rights Reserved

## ABSTRACT

### Analyzing A Video Game-Based Form of Gamification in Scientific Education and Its Effect on Learning

Carter Colton

Department of Physics and Astronomy, BYU  
Bachelor of Science

This thesis chronicles the creation of a new EdTech application called *Don't Study: Learn*. The website utilizes a dynamic video-game-based curriculum so that students can upload study sets from their classes; thus, it allows them to study for their upcoming exams while playing video games. The site's effectiveness was assessed via user surveys, market testing through email campaigns to local school districts, and feedback from preservice teachers at BYU. Users praised the site's smooth functionality and appealing design, but teachers questioned its effectiveness as a learning tool and its appeal to students. Districts acknowledged the potential of innovative EdTech tools but noted the challenges of cost and the abundance of existing options. I plan to remedy this situation by ramping up the game to make it more game-like and less rote memorization-oriented. I will also change the game's design to make the score more prevalent and incorporate score challenges and leaderboards. Right now, the score one receives is meaningless; however, incorporating a points and rewards system into the game can give the score value and increase student interest in playing.

Keywords: EdTech, STEM Education, Learning, Gamification

## ACKNOWLEDGMENTS

I would like to thank Adam Bennion for supporting me as my advisor on this project. His insights into the minds of students and teachers were invaluable. I would also like to thank Chris Verhaaren, as he helped me develop my idea in its earliest stages and pointed me towards Adam Bennion when I needed further support in the realm of scientific education. Furthermore, I acknowledge the assistance of Jared Rossean and Tyson Murray, who helped me flesh out my business model and come up with an MVP. I also thank Amanda Peterson, who directed me to Jared Rossean and helped connect me with resources and entrepreneurs that were essential in the creation of this thesis. Finally, I thank my parents, McKay and Missy Colton, who have supported and inspired me every step of my college journey. Their belief in me has propelled me onward. Additionally, I express my gratitude to all the teachers, users, and district employees who took my surveys and answered my questions.

# Contents

<b>Table of Contents</b>	<b>iv</b>
<b>List of Figures</b>	<b>v</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Defining Gamification . . . . .	1
1.2 Literature Review . . . . .	3
<b>2 Methods</b>	<b>6</b>
2.1 Research . . . . .	6
2.2 The Site . . . . .	9
2.2.1 The Home Page . . . . .	10
2.2.2 Users . . . . .	10
2.2.3 Study Sets . . . . .	11
2.2.4 The Game . . . . .	13
2.2.5 Data Storage and Access . . . . .	14
2.3 The Data . . . . .	15
<b>3 Results</b>	<b>17</b>
3.1 User Feedback . . . . .	17
3.2 Teacher Feedback . . . . .	19
3.3 District Feedback . . . . .	20
<b>4 Discussion</b>	<b>21</b>
<b>Bibliography</b>	<b>26</b>
<b>Index</b>	<b>28</b>

# List of Figures

2.1	The index.html, or Home Page, of the site. . . . .	10
2.2	The site’s dashboard. . . . .	11
2.3	Creating an account. . . . .	12
2.4	The process for creating study sets on the site. . . . .	12
2.5	Students can choose which study sets they want to study and then interact with the site’s flashcards. . . . .	13
2.6	Actual gameplay of the site’s tapping game. . . . .	14
2.7	The survey I created for user data collection. . . . .	15
2.8	My process for populating survey charts. . . . .	16

# Chapter 1

## Introduction

### 1.1 Defining Gamification

Gamification refers to the use of game elements in non-game contexts. [1] The stool of previous gamification theories rests on three legs: games with a focus on affect and motivation, games with a focus on behavior, and games with a focus on learning. [1]

Education has seen a decline in student interest in the sciences in recent years; therefore, gamification is relevant to teaching and curriculum building, as technology has been an effective means for reigniting the spark of student interest. [2]

Furthermore, modern gamification in learning exists on a continuum with two paradigms that I identify: exciting games that have no real impact on teaching a subject matter, and hopelessly boring practices that teach the material but have no right to be called games. On the hand of providing users with fun but frivolous educational games, there exist EdTech models like Luminosity, and on the hand of teaching for understanding but inducing student boredom, there are The Khan Academies of the private education community.

I tackle the problem of the two juxtaposing paradigms by finding a balance between learning for understanding and learning by having fun. *Don't Study: Learn* is an up-and-coming EdTech website that teaches students through video games. I built the website so that students could upload their study sets for specific classes to the site's games and study for their exams while playing video games. The site also hopes to incorporate group games and class-sized game-show-like games to get every student involved in the joy of learning. It also provides explanations, and articles, and will eventually provide innovative textbooks to teach students through the medium they understand: fun.

To understand the site's effectiveness in improving learning models, I gave a prototype to two preservice STEM teachers at BYU. I then had these teachers fill out a survey describing their experience with the site and how it could be useful in the classroom. With this data, I extrapolated the site's efficiency as an educational tool to successfully bridge the gap between learning for understanding and learning by having fun. I also surveyed two users about their experience with the site and sent an email campaign to school districts in Utah. With the user data, I hoped to realize the site's capacities as an application: its design, its ease of use, its navigability, and more. With the district data, I hoped to probe the EdTech market and determine who would be interested in such a site. After all, if nobody is willing to incorporate the site into their schools, the site's effectiveness at teaching would be lost.

The users generally felt that the site was easy to use and navigate. The users also felt that the site's design was appealing, but not too distracting. The teachers found problems with the teaching capabilities of the site. However, they did praise the site's spirit. They felt that the gamification aspects of the site constitute an EdTech market niche. The districts were wary of any site that did not have any safeguards for protecting student privacy. They also made comments about the extensive amount of EdTech tools out there and explained that many of them are extremely expensive.

I realize the importance of helping students see the essential nature of learning. I hope to aid students in learning how to learn and developing a passion for being curious. My ultimate goal

is to help all students unlock their genius gene. (I believe that every student has the ability to be successful at learning. The site attempts to help students learn how to learn effectively, thus unlocking their genius gene).

In this thesis, I begin by reviewing the literature on gamification. By looking to who succeeded and failed before me, I can better glean how my work fits in the gamification timeline. After that, I detail my methods, which are broken up into three parts: my research, my creation of the site itself, and my organization of the data. Next, I outline my results, which come from three main sources - users, teachers, and districts. Each of these groups has a unique perspective to give that allows us to gather the site's capabilities. Finally, I discuss my results: summarizing them briefly, analyzing them in context of previous work and the realm of gamification itself, and looking ahead to how I can improve, which includes explaining the site's shortcomings.

## 1.2 Literature Review

Gamification has been the focus of many theories over the years. Kalogiannakis, Papadakis, and Zourmpakis compiled an extensive overview of gamification over the last ten years. [2] They cite self-determination theory as one of the theoretical bases of gamification because it revolves around the satisfaction of three basic psychological needs: relatedness, autonomy, and competence. Gamification allows for one to address these needs through the action of playing and learning from games. They also cite goal-setting theory as a potential foundation for gamification. Since previous gamification has revolved around badges and challenges, goal-setting theory seems like an obvious core concept for gamification. Then, they also mention flow-theory, which emphasizes experiential learning. By coming to terms with the process of something, people can get a *feel* for it and recognize its flow. [2]

Krath, Schürmann, and Von Korfflesch gave their opinions on the theories of gamification as well. As we previously acknowledged, they split gamification into three categories: games with a focus on affect and motivation, games with a focus on behavior, and games with a focus on learning. [1] These three categories exist as the three legs of a stool upon which modern gamification stands.

Prior attempts at gamification in science education have relied heavily on virtual-world models. [3] These games allow students to operate within a virtual space and experiment with physical and chemical laws. For example, games may involve exploring a virtual world and identifying the properties of certain water sites. [3]

Prior research also highlights the importance of getting students involved in developing habits of the mind: curiosity, openness, engagement, creativity, persistence, responsibility, flexibility, and metacognition. [4] Regarding curriculum construction, Gray noted that curriculum is most effective when it revolves around powerful principles that answer questions. Working towards these principles helps students learn to think within their relevant field. Focusing on principles that answer a question provides the students with motivation for working out their own learning. [5] Obviously, these two focuses (on habits of the mind and curriculum construction) do not directly help me learn more about gamification. However, they do provide a scaffolding with which I can more effectively build the site and my educational games.

Previous work has shown the ineffectiveness of mechanical memorization models (these are models that focus on rote memorization, which relies on repetition to help one memorize). Ehrenberg set out to determine the effectiveness of mechanical memorization. His studies found that 40% of information is retained from mechanical memorization after one hour and 20% after a few hours. However, meaningful memorization results in information retention of 40% after as many as 30 days. Ehrenberg explains that the power of semantic memory (capitalizing on the brain's ability to remember concepts, experiences, general knowledge, connections, and associations) is 25 times that of mechanical memory. [6]

Furthermore, a previous study with a Croatian ICT group and an English control group provides relevant insights into gamification. The consensus of the study was that students need gamification as well as a reward system to be motivated. The study involved giving students a taste of gamification and then providing them with surveys to see what they thought. 70.6% of the Croatian ICT group ranked gamification as an impetus for motivation in class at a five out of five. 76.5% of the Croatian ICT group ranked the importance of reward systems as a catalyst for motivation at a five as well. Additionally, the Croatian group had higher marks than the English group, and the students in the Croatian group were the treatment group - meaning that they were given a reward for their efforts while those in the English group were not. [7]

Morschheuser, Hamari, and Maedche ran a study to determine whether cooperation or competition fostered more participation. Collaboration always beat out competition in their crowd-sourcing trials. However, they found that inter-team competition games foster the most participation and learning for students compared to individual competition games and total cooperation games. Therefore, people participate most when they feel part of a team and must cooperate, and when they are going against a common adversary. [8]

# Chapter 2

## Methods

### 2.1 Research

To garner research as I constructed the site, I consulted research papers about scientific education, ensuring I had a solid foundation to build my learning model. Studying these papers taught us that mnemonics are powerful tools for memorization [6], that gamification is most effective when there is a reward system involved [7], and that team competition games stimulated the greatest involvement in gamification models [8].

Based on principles in *The Complete Guide to Memory Mastery: Develop a Super Memory and Discover the Secrets of Mind Power*, I created a game for my site that capitalized on the power of visual association to help the brain remember [9]. From *Fostering Habits of Mind in Today's Students: A New Approach to Developmental Education* I learned that every game I develop must make use of a habit of the mind; that way, students will be expanding the capacity of their minds while on the site without simply memorizing [4]. I list these habits of the mind below, paraphrasing their definitions from *Fostering Habits of Mind in Today's Students: A New Approach to Developmental Education* and adding my unique perception and understanding to

them. Furthermore, these habits of the mind, tailored to *Don't Study: Learn's* education framework, greatly influenced the construction of the game [4]:

1. Curiosity - How much a student questions their understanding and seeks further knowledge.
2. Openness - The ability to express oneself and live authentically.
3. Engagement - The extent that which a student overcomes the fear of imparting their gifts and talents to others.
4. Creativity - How much a student embraces uniqueness and attempts to create original work.
5. Persistence - Tenacity; adopting the mantra of never giving up.
6. Responsibility - Developing the belief that we are 100 percent responsible for our actions, outcomes, thoughts, words, and beliefs.
7. - Flexibility - The ability to adapt and embrace change as the only constant.
8. Metacognition - Thinking about one's thinking.

Another resource I dove into focused on building a curriculum that makes learning last [5]. Based on this framework, I constructed my own curriculum. My curriculum's crux is not in its key concepts, questions, or learning outcomes, as one would see on a *Course Exam and Description* page for an AP course [10] (AP stands for *Advanced Placement* and is a type of class that allows students to take a test at the end of the year to earn themselves college credit). Instead, I developed explanatory principles, building my curriculum around them and including games to teach them. [5]

After diving into these resources, I developed a framework for the site's curriculum, which I call *The Stages of Learning*. This framework relies on the principles in *Unforgettable* [5], heavily influenced by my own beliefs and understanding:

1. The Core - The most important part of the learning process, the core of logical thinking. This helps students grasp the *why* behind what they are learning. Every principle should answer a *why* question. Additionally, this layer of learning strives to light the fire of motivation for the students. *The Core* endeavors to make learning fun and engaging so that students will start to love learning and will want to unlock their genius gene.
2. The Working Layer - This *Stage of Learning* is where students build their understanding; it is the *what*, whereas The Core is the *why*. It relies on rote memorization and basic rules so that students can grasp the *sphere* in which they operate when approaching problems in a new discipline. I call everything that answers *what* questions building blocks: things like vocabulary terms, facts, multiplication tables, assumptions, etc. In addition to being the *what*, The Working Layer is also the *how*. With the building blocks outlined above, students craft their own conceptual framework for solving problems. This includes thinking critically and finding patterns to ultimately create a new world of thought.
3. The Output Layer - This *Stage of Learning* is The Goal. By answering the *why*, *what* and *how* and practicing creating in a new sphere of learning, students teach themselves how to think, which is my goal. Optimal outcomes from this curriculum include improvements in critical thinking, learning the logic of problem-solving, and building new neural pathways. By the end of the curriculum, students should be able to explain the concepts and identify the implications and consequences of the principles learned.

When building the site, I turned to the BYU Web Programming web page to learn how to launch an EdTech startup and proceeded from there. [11] This involved much practice with web programming in HTML, CSS, and JavaScript on VS Studio Code. It also included exploring the AWS Dashboard and website.

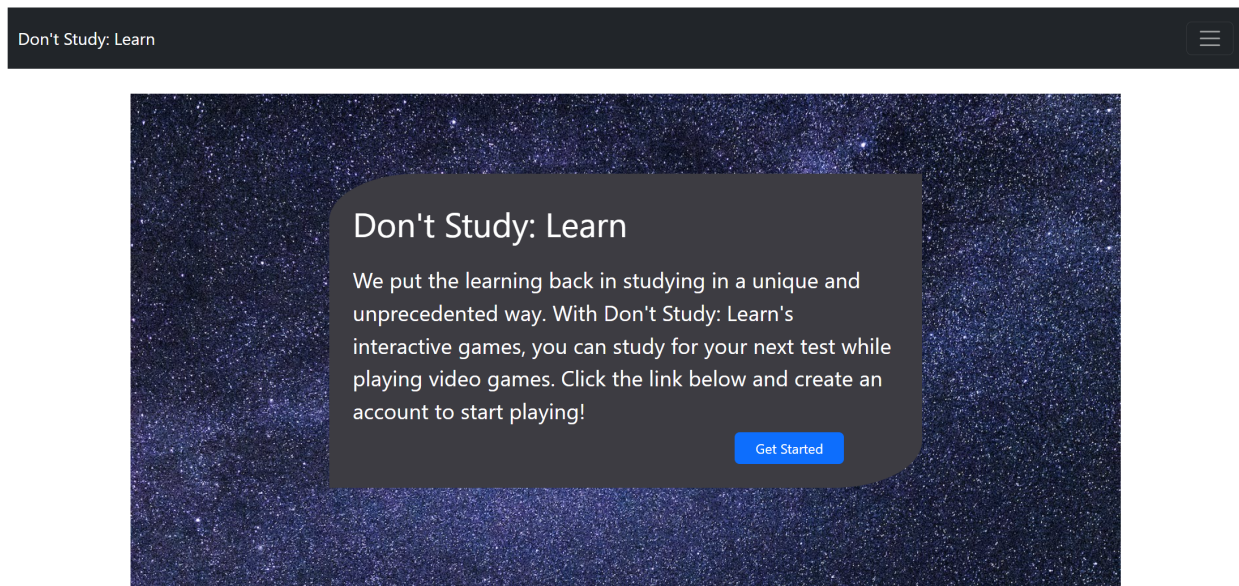
Furthermore, I counseled with education professionals (such as Adam Bennion and Chris Verhaaren) and explored other EdTech sites (such as Khan Academy, Lumosity, Elevate, Quizlet, and StudySmarter) to understand how to approach creating the site. These individuals and my study of these sites pointed me to effective resources and helped ensure I was teaching for learning. Additionally, to prepare for the business aspect of *Don't Study: Learn*, I utilized economic and entrepreneurial principles learned from various classes at BYU, including Financial Economics, Starting a Business, Applied Econometrics, Intermediate Microeconomics, and Game Theory.

In addition, I met with startup investors who were interested in exploring how they could be involved in *Don't Study: Learn's* progress. They helped us create a minimally viable product and projected the costs and revenues of the site. One such investor, Jared Rossean, admitted that the biggest problem I would face would be keeping the product close to me. He explained that many EdTech softwares start with radical ideas and then regress to the mean of becoming homework helpers or adopting band-aid solutions.

## 2.2 The Site

The site is hosted through AWS. AWS is a cloud computing platform on which I can launch and host the website. It uses HTML for the content, CSS for the design, and JavaScript for the dynamics. I coded the project using VS Studio Code, which is a text editor.

This section will detail the components of the finished product. It discusses the creation of the site, as well as the site's various pages. We focus on The Home Page, how users create an account, the study set capabilities of the site, the game, and how the site manages and stores data.



**Figure 2.1** The index.html, or Home Page, of the site.

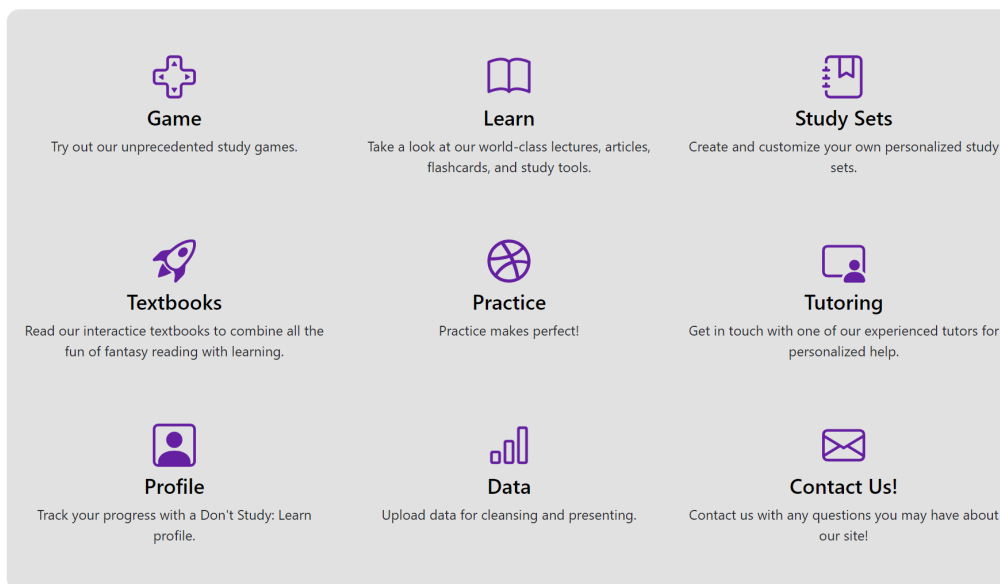
### 2.2.1 The Home Page

The initial page does not include too many colors and images to distract from the site's main purpose: to teach. Students can click on the *Get Started* button to dive right into the game (see Figure 2.1).

After The Home Page, users run into the dashboard. There, they can navigate to any place on the site. The dashboard offers services such as study set creation, explanations, articles, textbooks, learning practice, tutoring, and a profile page (see Figure 2.2).

### 2.2.2 Users

By clicking on the three bars at the top right of the screen, students and teachers can log in or create an account if they do not have one (see Figure 2.3). The account allows them to store and later access their personalized study sets. They can use these study sets to practice their content with flashcards or play the game. Creating an account has other benefits. Users with an account can access their profile and upload a profile image.



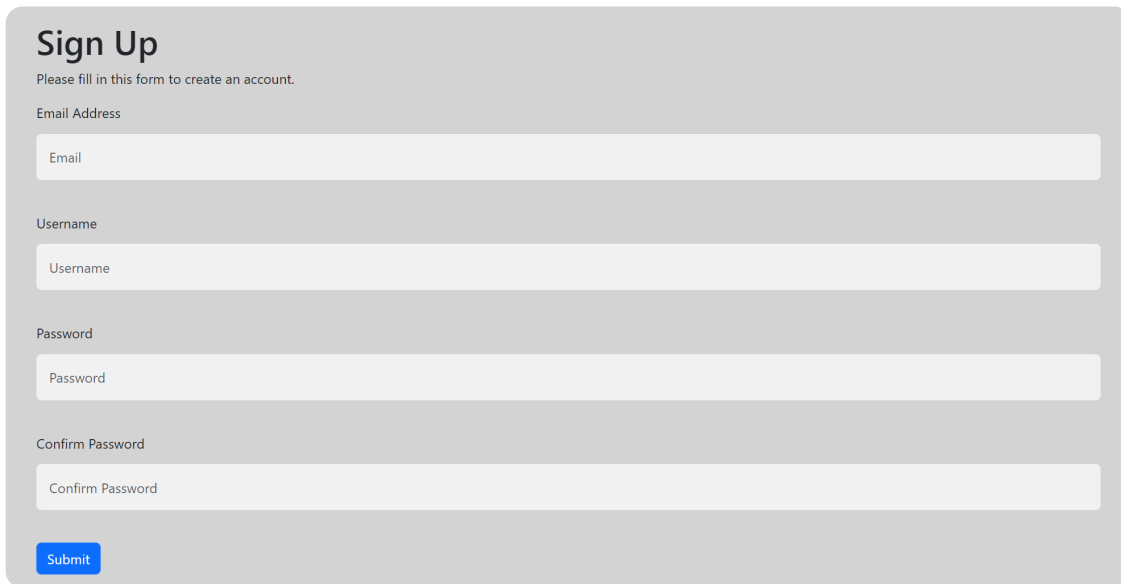
**Figure 2.2** The site's dashboard.

Some users have different access than others. I denote some users as *writers* and others as simply *users*. *Writers* can see everything that *users* can, and they can create, edit, and publish explanations and articles. Additionally, their sets are displayed for everyone to see on the *Search Study Sets* page.

### 2.2.3 Study Sets

By navigating to the *Study Sets* page, students and teachers can create study sets (see Figure 2.4) and upload them to the game, or they can study their creations with flashcards (see Figure 2.5).

The process for creating study sets is complex; therefore, I direct the creation of the study sets to teachers and content creators. When creating a set, each term-definition pair has a term, definition, term key, and definition key form. In addition, each of those forms has a corresponding option to upload an image. The term and definition images get sent to MongoDB and are retrieved on the flashcards, while the key images are stored on MongoDB but are retrieved during the game. MongoDB is a free database management system where users can store content from their sites.



**Sign Up**  
Please fill in this form to create an account.

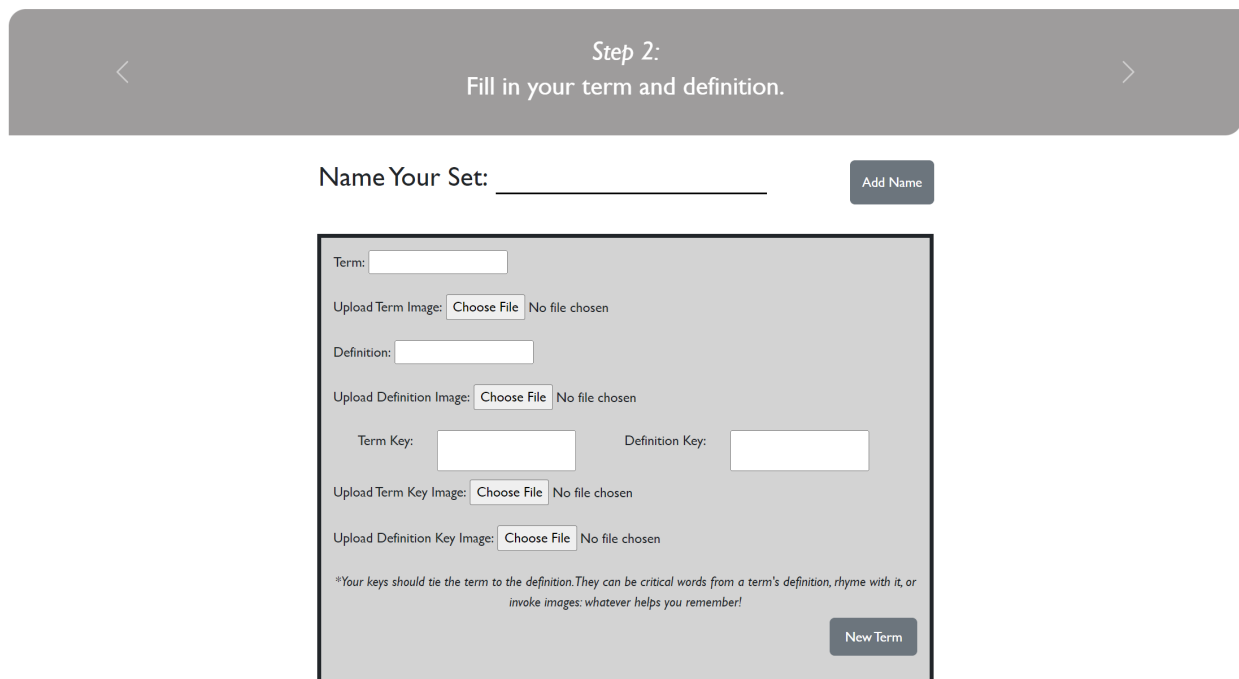
Email Address

Username

Password

Confirm Password

**Figure 2.3** Creating an account.



Step 2:  
Fill in your term and definition.

Name Your Set:

Term:

Upload Term Image:  No file chosen

Definition:

Upload Definition Image:  No file chosen

Term Key:  Definition Key:

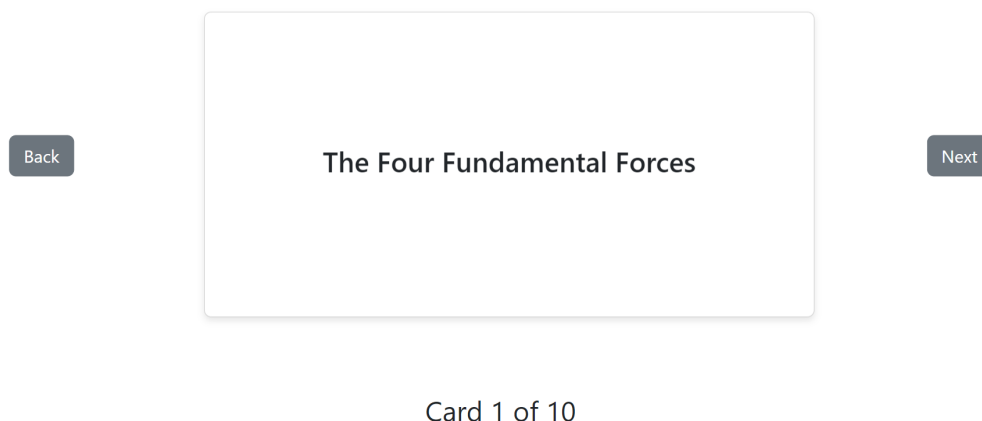
Upload Term Key Image:  No file chosen

Upload Definition Key Image:  No file chosen

\*Your keys should tie the term to the definition. They can be critical words from a term's definition, rhyme with it, or invoke images: whatever helps you remember!

**Figure 2.4** The process for creating study sets on the site.

## Fundamental Forces



**Figure 2.5** Students can choose which study sets they want to study and then interact with the site’s flashcards.

### 2.2.4 The Game

This project’s culmination is the site’s game, which uses visual cues to help students tie terms to their definitions. Students tap a center image, corresponding to a term. With each tap, an image corresponding to the term’s definition pops up at the bottom (see Figure 2.6), continually filling the bottom row until the images change to the next term-definition pair in the study set.

I base the idea for the game on memory mastery principles from *The Complete Guide to Memory Mastery: Develop a Super Memory and Discover the Secrets of Mind Power* [9]. It would be most effective if I could get the students to choose their own visuals for practice in the game, but that is beyond the scope of my project. I also capitalize on the power of visual association and rhyme to help the vocabulary stick in students’ minds. [6]

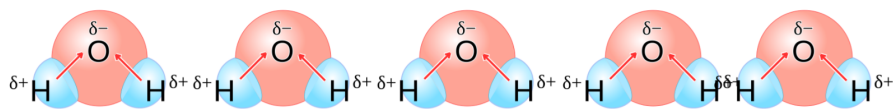
For example, in one set, I tie cohesion to the keyword legion. Students would then play the game and see a picture of a Roman legion. As they tap the button, scientific images of water molecule cohesion will pop up at the bottom of the screen. The effect of such a memorization tactic is twofold.

Score: 14

Water = Life



Because of its properties



**Figure 2.6** Actual gameplay of the site's tapping game.

First, it is much easier for people to remember an image of a Roman legion than a scientific diagram. And second, the Roman legion visual cue implies cohesion because of the unity of the ancient army.

### 2.2.5 Data Storage and Access

The site utilizes MongoDB to store the data for each user, the study sets, and the explanations and articles. Additionally, all the images are hosted on Cloudinary, and their links are stored in MongoDB for retrieval in specific sets. I use Express and Node.js as the backend for the site. Express is an app that increases the effectiveness of Node.js and Node.js allows for all the dynamics of a site to center on one index.js script. Using Express, I can call my database.js script and use my keys to access my MongoDB account and store and retrieve data.

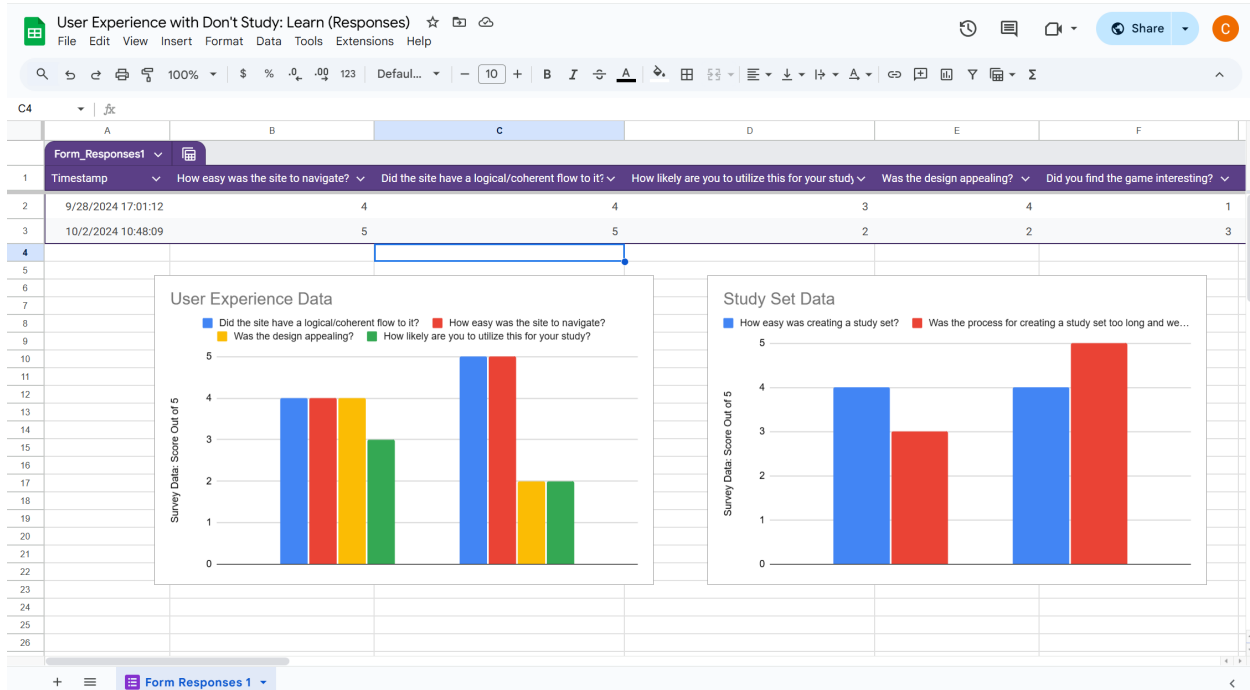
The screenshot shows a Google Form interface. At the top, the title is "User Experience with Don't Study: Learn". Below the title is a text area with the instruction: "Fill out these questions after you try out the website. This survey should take 15 minutes." The form contains two Likert scale questions. The first question is "How easy was the site to navigate?\*" with a scale from 1 to 5. The labels are "Very difficult" at 1 and "Very easy" at 5. The second question is "Did the site have a logical/coherent flow to it?\*" with a scale from 1 to 5. The labels are "Not at all" at 1 and "Definitely" at 5. The form is displayed in a light purple theme.

**Figure 2.7** The survey I created for user data collection.

## 2.3 The Data

I gathered user data for my site through Google Forms by sending out an instruction sheet to people I know that asks them to go through the site and fill out a survey of my creation. My survey consisted of nine multiple choice questions where the respondent was asked to rate a characteristic of the site or some part of their experience with the site on a one to five scale. I then included 12 other written questions so that the respondents could give more detailed feedback (See Figure 2.7).

The survey I gave to teachers was similar. Again, I used Google Forms to create the survey. I selected teachers from a science education class at BYU. The promise of extra credit in that class helped to incentivize them to complete the survey. I included some questions specific to teaching and learning that were insightful for teachers but unnecessary to include for users. For example, one of my teacher questions was, *How likely are you to utilize this in your teaching methods?* The teacher survey consisted of nine multiple-choice and ten written questions.



**Figure 2.8** My process for populating survey charts.

After that, I used the *View in Sheets* capability of Google Forms to view my data in Google Sheets. From there, I used the *Insert Chart* feature to compute bar charts for the multiple-choice survey data so that I could easily glean the scores given and calculate averages (See Figure 2.8).

To gather feedback from districts, I launched an email campaign to the technology specialists of various school districts in Utah. In each email, I asked three questions:

1. Is your district currently paying for any EdTech software, or did you develop it yourself?
2. How much does your district pay for its use of EdTech software? Is it on a per-student basis? Is it on a subscription?
3. Does your district have an interest in exploring the newer EdTech softwares out there and is it always looking to enhance learning through technology?

# Chapter 3

## Results

This section details the main findings of the surveys and email campaigns conducted. It begins with the feedback from the two users who took the survey about the site's effectiveness as a web tool; their consensus was positive for the flow and design of the site but negative for its mobile experience. Then, the section moves on to the two preservice teacher responses; their consensus was positive for the site's design and appeal but negative for its capacities as a teaching tool. Finally, this section ends with the feedback I received from my district email campaign; the districts that responded showcased a wary view of newer EdTech tools.

### 3.1 User Feedback

I found that the overall user experience for my site was good. my respondents rated the user experience at an average of 3.6. We asked the users four questions about the site design and experience:

1. Did the site have a logical/coherent flow to it?
2. How easy was the site to navigate?

3. Was the design appealing?
4. How likely are you to utilize this for your study?

One of the two users scored questions 1-3 at a four and ranked question 4 at a three. The other user marked questions 1-2 at a five and questions 3-4 at a two. The Home Page was well-liked, as well as the site's scaffolding. The site ran fine and the users did not have a problem creating accounts and navigating.

My data on study sets was similarly distributed. The two users found it manageable to create sets but were neutral regarding the length of the study set creation process. They both rated the ease of study set creation at four and the length of the process and amount of information petitioned at three and a five.

However, half of my users found the site difficult to manage on mobile. The site's function and its design came in at around a 2.5 on average for one of my users and at a 4 on average for another.

The written responses were favorable. Most people found the site easily navigable and said it ran smoothly. They did identify a bug: there is no button for navigating back to The Home Page from the flashcards or the game. Additionally, the users found the study sets and the flashcards more useful than the game. The users also complimented the explanations portion of the site, stating that the *Fun With 51* article (one of the public math articles on the site) was interesting.

Survey respondents also highlighted the importance of including a points and reward system. This comment is particularly interesting and will be discussed further in my Discussion section.

While the flow of the game was praised, the users mentioned that a more dynamic design could improve the site's usability. They postulated that the blandness of the design may be a hindrance to student learning rather than a help to it.

## 3.2 Teacher Feedback

Like the users, teachers found the site easy to navigate, that it had an appealing design, and that creating study sets was user-friendly. The two teachers I surveyed ranked the overall site experience at an average of four out of five based on these criteria:

1. How easy was the site to navigate?
2. How easy was creating a study set?
3. Was the process for creating a study set too long and were there too many images?

One teacher ranked the teaching capabilities of the site at a 2.75, giving the site's ability to not distract from the learning experience a four, the likeliness to use this tool in teaching methods a two, the game's capacity to teach for understanding rather than solely being a memorization tool a two, and his or her perception of student interest in the game at a three.

The other teacher ranked the teaching capabilities of the site at a 3.25, giving the site's ability to not distract from the learning experience a five, the likeliness to use this tool in teaching methods a three, the game's capacity to teach for understanding rather than solely being a memorization tool a three, and his or her perception of student interest in the game at a two.

The teacher's written responses were insightful. One found the game to be more effective than the study sets because it strays away from brute memorization tactics. The other explained that the study sets were more effective because of the flashcards. Both teachers, however, explained that the game had some bugs with running (one teacher got stuck in the middle of the study set iteration) and that they did not see the point of the game.

Furthermore, the teachers did not have any problems with the overall design of the site. They also praised the gamification elements of the site and explained that the concept of tying vocabulary words to key images has real promise at helping students in their studies.

One teacher suggested making a tutorial to teach the students how to play the game and to explain its purpose. Both teachers suggested that the current site would not be effective at improving teaching methods. However, they both think that the idea is great. They explained that streamlining it so teachers can make classroom links and see their student's data would be essential. Also, they explained that giving students access to more study sets is a must, as they do not see many students having the desire to go through the entire process of creating a study set.

### **3.3 District Feedback**

I contacted Alpine School District to probe the market and see if they would be interested in a new EdTech website before launching the email campaign. Their administrator of technology responded with valuable information. He explained that any school-sponsored technology program has to have Data Privacy Compliance. [12] Then, he explained the importance of having proper filters. Alpine School District blocks most games; therefore, the site cannot have access to any non-educational video games, or it runs the risk of being blocked.

Additionally, I received a response from my email campaign from Cache County School District. Their Executive Director of Teaching and Learning explained that they use BYU Independent Study and pay for it. Furthermore, Cache County School District uses so much EdTech that she was unable to number all their uses. Additionally, she explained that they have a Digital Teaching and Learning specialist who keeps up to date on all the relevant EdTech tools available. However, they are wary of trying new tools because, as she explained, EdTech tools are expensive and ever-changing.

# Chapter 4

## Discussion

*Don't Study: Learn* is a website that attempts to make learning fun through gamification. Users grasp their material by organizing their content into study sets and playing games updated with their study set data. I found that users enjoyed the design and appeal of the site. They also felt the site was logical and navigable, giving it a four out of five in these categories.

Furthermore, the users felt that creating sets was easy (again, giving that aspect of the site a four out of five on average); they were equally optimistic about the extensiveness of the study set creation process, giving it a four out of five on average. The site's capacity on mobile was a glaring issue, as the mean rating for my mobile phone survey questions was 3.25.

While most of the users saw the site as a powerful memorization tool, given that the users rated their likeliness to utilize my tool for study at a 2.5, the site's ability to help one memorize may be of little use; a great tool can never be effective if nobody uses it. However, neutrality carries the benefit of being sway-able; therefore, adding games, providing further direction, and implementing a reward system could bring that survey average up to a four or a five. [7]

I also note the power of the written responses I received. Users commented on the site's ease of use, general lack of bugs, the power of the flashcards, and the uniqueness of the explanations and articles.

One of the written comments mentioned utilizing a points and rewards system to motivate learners; this idea is insightful. As I saw in the experiment with the Croatian ICT group, students need gamification as well as a reward system to be motivated. 76.5% of the Croatian ICT group ranked the importance of reward systems as a catalyst for motivation at a five. [7] These findings are consistent with the user feedback I received.

The teacher feedback showed that the site has major flaws with its teaching capabilities. As it is now, students may struggle to create sets and understand the purpose of playing the game. Having content creators and teachers be the main producers of study sets is the best course for correcting this situation. To address the confusion of playing the game, I could include a tutorial at the first of the game for new users to understand what they are doing. Furthermore, I could also incorporate a short matching test at the end of the tapping game to further solidify the content in the users' minds.

The teachers also pointed out some bugs and explained that the prototype site was not ready to be used by teachers. However, they were more optimistic about the site's potential. To achieve its potential, I would like to polish the game so that it is free of bugs and add a points and rewards system at the advice of the teachers surveyed. These points could be translated to other parts of the site. For example, I could have the points go towards personal badges, leader boards, extra credit points in classes, and more.

Furthermore, the teachers praised the site's innovation in the field of gamification and explained that using key images to help students connect terms to definitions has incredible potential. As explained in the work of Ehrenberg and Lorayne, visualization, rhyme, association, and randomness are powerful catalysts for memory. [6,9] The teachers clearly agree with this prior written work, and I feel that the key image model will be extremely effective in helping students memorize terms and definitions in the future.

The district feedback I received highlighted the importance of protecting students' privacy and ensuring that learning is prioritized over entertainment. I also learned that districts are flooded with

EdTech tools and that many of them are already paying for multiple EdTech tools. Furthermore, the surveyed district's perception of Education Technology is that it is expensive and ever-changing.

This district feedback shines a light on the importance of EdTech tools to differentiate themselves from the masses and add value to the market. But even with all the tools in the market, there is still an obvious need for a radical change in education. Students still struggle to learn; one in five U.S. adults admit to feeling severe math anxiety; 67% of U.S. teachers say that math anxiety is a problem for their students; one in four of those very teachers admit that math can be a struggle for them too. [13]

My site attempts to remedy this situation. Jared Rossean, a startup entrepreneur, explained that many EdTech tools begin with radical ideas to solve the problem cited above, but most of them regress to the mean and settle as homework helpers or become another classroom. *Don't Study: Learn's* mission is to make learning stick, but more importantly, its mission is to foster a love for learning in students by helping them unlock and appreciate their genius gene.

Prior research also highlights the importance of getting students involved in developing habits of the mind: curiosity, openness, engagement, creativity, persistence, responsibility, flexibility, and metacognition. [4] The game provides students with the tools to persist in a video game format and engage with their study sets visually and intellectually by making connections.

Others took a different approach to gamification. Instead of capitalizing on rote memorization and crafting connections between terms and definitions, they introduced their users to a virtual world that allowed them to explore and learn about water pollution in a field-like environment. [3] I would like to develop full immersion game experiences as they did; however, my time and resources do not allow for it yet.

Previous work has shown the ineffectiveness of mechanical memorization models. Ehrenberg's studies found that 40% of information is retained from mechanical memorization after one hour and 20% after a few hours. However, meaningful memorization results in information retention of

40% after as many as 30 days. Ehrenberg explains that the power of semantic memory (capitalizing on the brain's ability to remember concepts, experiences, general knowledge, connections, and associations) is 25 times that of mechanical memory. [6]

*Don't Study: Learn* attempts to embody Ehrenberg's approach to memorization. The site uses games and associations to help one memorize. It focuses on fostering semantic memory rather than drilling terms and definitions into students' minds. The explanations and curriculum rely on teaching principles and helping students understand the *why* behind what they are learning by honing in on key principles and teaching students a method of thinking. It also attempts to make learning fun, which is essential for success in memorization - as Ehrenberg points out - we can hardly ever memorize something if we do not want to memorize it. [6]

I also understand the untapped potential of cooperation games. In fact, other researchers found that inter-team competition games foster the most participation and learning for students compared to individual competition games and total cooperation games. [8] I would like to include the possibilities for such games on my site. I could create a *Jeopardy* game or a team debate game or other team cooperation games to heighten information retention and increase participation. This will allow students to brainstorm in teams and compete for points against other teams: few things can light the fire of participation more than this.

My site succeeds in a variety of ways. It is visually pleasing and easily navigable. This means that I can confidently say that any hindrance to learning or teaching can be attributed to the game itself and not the site's design. Additionally, one of the preservice teachers surveyed believes that the site has powerful potential as a memorization tool, and the flashcards provide a nice respite from the assault of the senses that the game can induce. Furthermore, the process of creating a study set was well received by users, even if creating the sets themselves was extensive and may not work for students.

With one person working on the development of the site and limited time, I could not build an educational tool on the scale that I desired. While some capacities do exist for using my game to teach for understanding, it is most effective as a memorization tool. Furthermore, I only surveyed a few users and teachers at BYU; therefore, my pool is not representative of the state of Utah or the nation, meaning there is little external validity to my findings.

I recognize that many students will be unmotivated and unwilling to go to such lengths to create entire study sets. Therefore, I believe that the study set creation is most effectively placed in the hands of TAs, teachers, and content creators. I also note that teachers have no means of identifying when students are studying and how much time they spend on the site; this would be relevant data. Therefore, I plan to add this feature to the site.

Creating classroom links that teachers can give to their students would also be effective. This would provide needed organization and exploit the power of competition with classmates and improve learning outcomes. [8]

I see also the need to ameliorate the site's capacities on mobile. Many students and users use their phones for studying; therefore, getting the site mobile-ready is a priority.

From the respondents surveyed, I glean that the site does well on a design level and as a memorization tool. Further efforts must be made to improve the site's outcomes for student comprehension. Its ability to teach and make learning fun must be precipitated by great designs, an understandable user experience, and a reward/organizational system for teachers and students. I will also exhaust my time and resources to create a sound curriculum with explanations, articles, and textbooks.

# Bibliography

- [1] J. Krath, L. Schürmann, and H. F. von Korflesch, “Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning,” *Computers in Human Behavior* **125**, 106963 (2021).
- [2] M. Kalogiannakis, S. Papadakis, and A.-I. Zourmpakis, “Gamification in Science Education. A Systematic Review of the Literature,” *Education Sciences* 11 (2021).
- [3] S. A. Barab, B. Scott, S. Siyahhan, R. Goldstone, A. Ingram-Goble, S. J. Zuiker, and S. Warren, “Transformational play as a curricular scaffold: Using videogames to support Science Education - *Journal of Science Education and Technology*,” SpringerLink (2009).
- [4] J. Fletcher, A. Najarro, H. Yelland, and E. Lardner, *Fostering Habits of mind in today’s students: A new approach to developmental education* (Routledge, Taylor Francis Group, 2023).
- [5] W. M. Gray, *Unforgettable: Enabling deep and durable learning* (RESOURCE Publications, 2016).
- [6] O. Ehrenberg, “Memorization and memory. The best way to memorize in long-term memory The most effective ways to memorize information for schoolchildren,”.

- 
- [7] P. Vranešić, K. Aleksić-Maslač, and B. Sinković, “Influence of Gamification Reward System on Student Motivation,” In *2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, pp. 766–772 (2019).
- [8] B. Morschheuser, J. Hamari, and A. Maedche, “Cooperation or competition – When do people contribute more? A field experiment on gamification of crowdsourcing,” *International Journal of Human-Computer Studies* **127**, 7–24 (2019), strengthening gamification studies: critical challenges and new opportunities.
- [9] H. Lorayne, *The Complete Guide to Memory Mastery: Develop a super memory and discover the secrets of Mind Power* (MJF Books, 2002).
- [10] C. Board, “Course Exam Pages – AP Central | College Board,”.
- [11] B. C. Department.
- [12] SDPCResourceRegistry.
- [13] S. D. Sparks, “The myth fueling math anxiety,” 2021.

# Index

- AWS, 9
- Cloudinary, 14
- Collaboration, 5
- Competition, 5
- CSS, 9
  
- Districts, 20
- Don't Study: Learn, 2
  
- EdTech, 1
- Express, 14
  
- Gamification, 1
  - three legs of gamification, 1
  - two paradigms of gamification, 1
- Genius gene, 3
- Google Forms, 15
  
- Habits of the Mind, 6
- HTML, 9
  
- Inter-team competition games, 5
  
- JavaScript, 9
  
- Memorization, 4
  - meaningful memorization, 4
  - mechanical memorization, 4
  - semantic memory, 4
- MongoDB, 14
  
- Node.js, 14
  
- Study sets, 11
  
- Teachers, 19
- The Stages of Learning, 7
  
- Theory, 3
  - flow-theory, 3
  - goal-setting theory, 3
  - self-determination theory, 3
  
- Users, 17
  
- VS Studio Code, 9