Studying in a Flash: Untapped Potentials of Flashcard-Study Gamification

Sean C. Braithwaite

Faculty of Animation, Arts and Design Sheridan College, Canada

braithse@sheridancollege.ca

Friday, December 14, 2018

Abstract

How might flashcards be gamified to improve their study effectiveness? In this deepdive investigation, 21 online flashcard-study tools and services were investigated for use of gamified study techniques, with specific investigations on the techniques used by Duolingo and Quizlet. Results showed that many online flashcard-study tools implemented gamified flashcards to encourage more effective and ongoing study. Conclusions highlight new directions in gamified study, and how they might be leveraged in games to aid in the storage and recall of game information.

Keywords: Gamification, Gamified Study, Flashcards, Quizlet, Duolingo

Introduction

When I was ten-years-old, I ran into a seemingly-life-ending conundrum when my inability to multiply in sevens caused my parents to restrict my blessed Warcraft III hours. This was because, in school, we were learning our multiplication tables and seven was a number which didn't multiply nicely in my head. Yet my parents were not going to have a child who stopped functioning when the number seven appeared, so they brought out a tool which they themselves had used for studying: flashcards. We drew out the equation on the front and answers on the backs of dozens of cards and then practiced every day for weeks until I knew all the numbers' pairings, including sevens. Then, mercifully, it was back to Warcraft III.

With time, my game of choice changed alongside my area of study. Now, having graduated from the multiplication table and into the games industry, I've found myself exploring flashcards again, this time from a different perspective. Flashcards, it seems, have aged incredibly well. In recent years, flashcards have become more accessible than ever through web and mobile services such as Quizlet and Duolingo, yet it is not just accessibility which led them to success. These massively-successful study services set themselves apart from competitors with something equally impactful, yet lesser served: gamification. Thus I had a thought, how might flashcards be gamified to improve their study effectiveness?

The potentials of flashcards' gamification is significant to both game developers and those in educational; it is an intersection of great opportunity. The educational market is ripe worldwide with hundreds of millions of students seeking improved returns on their study, and professors with access to greater classroom technology and funding than ever before. Already, others such as Duolingo have shown examples of lucrative businesses leveraging

gamified flashcard-study, yet there is room to grow the market, its credibility, and games'

presence in the classroom. Topics covered in the following article include:

1. Research on effective study techniques and their connection to flashcards

2. Analyses and critiques of Duolingo and Quizlet's gamification of study techniques

3. Proposals of gamified study systems for Duolingo and Quizlet

Part 1. Effective Study Methods, Material, and Flashcards

What elements contribute to effective study, and how might they be applied to

flashcards? Before understanding how Duolingo and Quizlet gamify flashcards, it's important

to understand why. Why are flashcards the study-medium of choice? In a 2013 article

investigating the effectiveness of ten learning techniques, it was concluded that only practice

testing and distributed practice were of 'high utility' to memorization and recollection

(Dunlosky et al, 2013). These techniques are among 16 principles of Active Learning

(Kosslyn, 2017), and are the first of several active-study techniques which flashcards

leverage.

Practice Testing

Practice testing is a study technique which challenges memorization by asking

questions. This challenges a student's recollection abilities, and is proven to strengthen

long-term memory (Cowan, 2008). By answering questions, gaps in recall can be determined.

Importantly, flashcards are effective for practice testing as they encapsulate a single

question and answer onto a card. There is no fudging the question or thinking that 'oh, I knew

that' as an answer must be committed to before being shown, even if that answer is nothing.

Distributed Practice

Distributed practice is simply practice testing, over time. The simplest application of distributed practice is daily study. There are more complex, digitized applications too, such as the SuperMemo algorithms. These systems predict when a studied fact is due to be forgotten, and prompt the student with a related question to check in. Each prompt extends the time to the next related one, going from days to weeks to months as the information is committed to memory (Wozniak, 1998). This type of automated distributed practice is especially useful as it reduces the quantity of material to study once initially covered, freeing up time.

Flashcards can be used to distribute practice, as they offer a consistent testing platform with a single question and answer per card. As flashcards have distinct questions, it is also simple to trend one's progress over time learning a series of questions' answers.

Chunking and Sequencing

In addition to the effective *ways* to study above, there are types of *content* which are easier to commit to and recall from memory. An example of this is *chunking*, where related ideas are gathered together to aid in retrieval. An extension of this concept is *sequencing*, which is a collection of chunks connected by a story. This can be achieved with flashcards by ordering them into sequences, or by grouping them into smaller study sets.

Dual Coding

Dual coding is another theory which emphasises the importance of creating supplementary connections to learned material with verbal associations and visual imagery (Brunye, 2008). Using imagery, reading aloud, or being read flashcards aloud are applications of the dual coding study technique.

Mnemonics and Image Mnemonics

A mnemonic is any system facilitating recall, an example of which is the acronym used to memorize the visible colour-spectrum, ROYGBIV (red, orange, yellow, green, blue, indigo, violet). In addition to their pun or acronym forms, mnemonics include coined sayings such as 'In 1492 Columbus sailed the Ocean Blue,' rhymes and jingles, expression statements where the first letter of a sentence spells a phrase, poems, or anything connecting new knowledge to existing. Mnemonics are especially useful studying sets of information which are otherwise difficult to connect. Dunlosky et al found 'moderate utility' in "the use of the keyword mnemonic for learning foreign-language vocabulary, and the use of mental imagery for comprehending and learning text materials." (2013, pg. 21) However, before their article examined image mnemonics they noted that there is enough science on imagery that "it is evident that the use of imagery can enhance learning and comprehension" (pg. 21, 2013)

Imagery is an aspect of mnemonics important to their role in study. The use of imagery is an example of dual coding, aiding in memorization and recall. Additionally, the specific usage of unusual drawings can aid in the active recall of information (Parker, 1998). The specific use of unusual imagery is known as the Von Restorff effect. Effective application of mnemonics allows for the sequencing and collection of large amount of information in a singular as in figure 1, *Gregorian Calendar Image Mnemonic*.
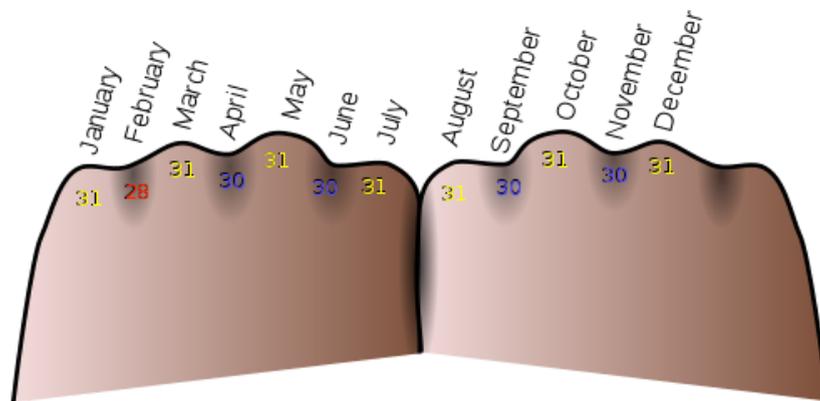
Gregorian Calendar Image Mnemonic

Figure 1. Stam, Tijmen. (2012). Month - Knuckles(en). Licensed under Creative Commons Attribution-Share Alike 3.0 Unported on Wikimedia.org. An example of an image mnemonic used to memorize the number of days in each month of the Gregorian calendar.

Flashcards are an effective way of testing with mnemonics, as an image or text can be used for either side of the card. Mnemonics are also an effective way of sequencing information on flashcards.

Effective Study Recap

What elements contribute to effective study? Collectively, active study, practice testing, distributed practice, chunking and sequencing, dual coding, mnemonic and image mnemonics form the *elements of effective study*. Each element has been proven to aid in the retention or recall of information. Flashcards are able to support each of these elements through their contained content, or how they are delivered, resulting in a highly-malleable, transferrable, and accessible tool for study. The preservation of these elements going from flashcard to gamified flashcard is integral to maintaining the flashcards' value to studying, and will be analysed in the coming section.

Part 2. Duolingo, Quizlet, and friends: Existing flashcard gamification

With an understanding of effective study techniques and how flashcards leverage them, it is possible to look to existing examples. When investigating flashcards, I found dozens of web-based services for creating, sharing, and testing. Each offered unique uses of flashcards and methods of gamification, ranging from student-fed questions and answers to pre-made academic courses to actual games. To form a comprehensive understanding, Duolingo and Quizlet, two of the most-successful famified flashcard-study services are examined in-depth, with several-dozen others collectively surmised afterwards. With each service, the implementation and gamification of each effective study technique is considered.

Study-Based Flashcard/Q&A Interfaces

Duolingo Banner and Mascot Character

Figure 2. Red-Rat-Writer. (2015). Duolingo Wallpaper. Licensed under Creative Commons Attribution-Share Alike 3.0 Unported on Duolingo.Wikia.com.

What is Duolingo

Duolingo is a language-study service launched in 2011, since then it has become one of the largest services of its kind with 200 million users and courses covering over 81 unique

languages. Duolingo implements flashcards in a straightforward way which offers some

breadth to users, prompting students with a question to translate to or from their learning

language. There are also spoken-word and reading activities too, but they are not reliant on

flashcards and are thus excluded.

Duolingo English-to-French Study Typed Answer

Figure 3. Duolingo. (n.d.) Retrieved from http://www.duolingo.com/ Screenshot by author.

Example of English to French question/ answer flashcard on Duolingo.

Duolingo Study Element and Flashcard Gamification

Duolingo offers variant levels of difficulty. While studying, Duolingo allows users to

select from a word-bank rather than directly typing answers with the click of a button.

Word-bank phrases are also defined when rolled over. These allow users the flexibility to

decide whether to use them, and help new users progress. There are also more traditional

testing modes available, which remove these aids and introduce a lives system. Together,

these features allow for students to define the level of challenge they desire. In this context, difficulty affects the resources available while studying with flashcards. Further examples of difficulty and gamification are offered through a progression system through language topics, with each activity building on previous knowledge and unlocking additional areas of focus.

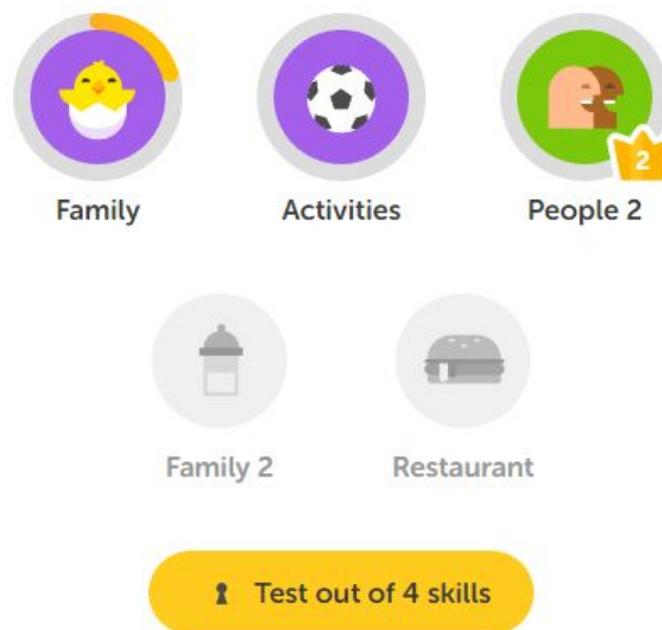Duolingo English-to-French Topic Progression

Figure 4. Duolingo. (n.d.) Retrieved from http://www.duolingo.com/ Screenshot by author. Example of progression through language topics on Duolingo.

These progressive topics build on existing knowledge and each contain a set of flashcards related to their topic. This is an application of chunking. Each topic can be repeated several times with increasing difficulty for additional reward.

Duolingo also offers voiceovers for pronunciation, and activities where students speak into a mic to check their pronunciation. These make it clear how to pronounce a phrase, and are conducive to dual-coding.

Layering even more gamified systems into their service, Duolingo also offers players a currency called *Lingots,* an account level, experience, achievements, leaderboards, a friend system, social-networking, a streak system which rewards players with Lingots for studying to one's 'XP' goal over a series of consecutive days, and a shop where players can spend their currency on power-ups, service upgrades, and bonus skills. The items which you can purchase from the store are also gamified, with one allowing for players to skip a day of study while maintaining their streak, and another an actual 'double-or-nothing' bet that is rewarded if they maintain a seven-day streak. I was prompted with one of these 'double or nothing' challenges when I began using Duolingo, and had it come to mind several times when I thought to skip out studying for a day. Together, these gamified systems promote distributed practice, and by rewarding users for testing rather than just logging in, promote practice testing.
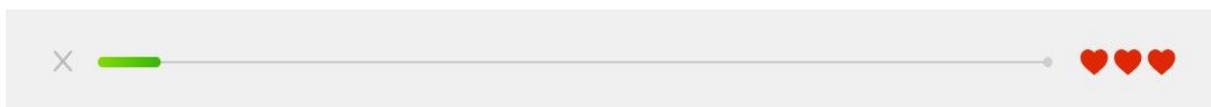
Duolingo Test Progression Bar

Figure 5. Duolingo. (n.d.) Retrieved from http://www.duolingo.com/ Screenshot by author. During a quiz on Duolingo, both progression and lives are provided.

All of Duolingo's gamified systems work in tandem to create a very convincing sense of progression, with frequent rewards and second-to-second study feeling rewarding. Additionally, the systems make it clear how much remains to study without feeling overwhelming as result of the progression systems.

Quizlet Mobile Advertisement

Figure 6. Quizlet (n.d.) Retrieved from http://quizlet.com/ Quizlet page slideshow image on Google Play store.

What is Quizlet

Quizlet is a web-and-mobile based study service launched in 2007 which allows users to create, test, and distribute groups of flashcards known as study sets. It is a service used monthly by over 50 million students, including two-thirds of the United States' high-school students, and one-third of their college attendees ("About Quizlet | Quizlet," 2018). Whereas Duolingo offered in-depth flashcard services for learning language, Quizlet offers a similar depth of services but with user-created flashcards. As a result of Quizlet's breadth of focus, there is lesser control of the experience for designers, and the service respectively has fewer gamified systems. Despite this, Quizlet offers a series of unique and interesting examples of flashcard-study gamification.

Flashcards are implemented in their traditional manner on Quizlet, allowing users to define a question and answer. The service facilitates flashcards' creation, distribution and management through its various services including import from other packages such as

Excel, settings for the visibility and editability of a set, and auto-completion of questions and answers based on publicized cards. Their flashcards support text, audio, per-card and per-side language selection, and images. Diagrams can also be created which offer similar question/ answer support, with the ability to add questions to points on a diagram, and selectively blur image content to aid in study. These imagery and diagram systems enable the use of mnemonics. Finally, flashcards can be reversed so that their answer becomes the question, allowing for reversed and adaptive testing.
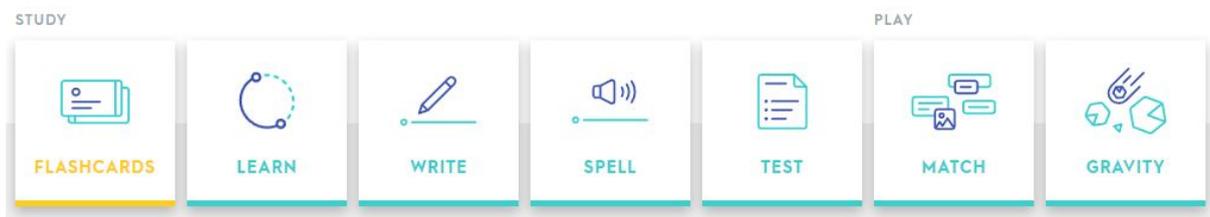
Quizlet Activity Bar

Figure 7. Quizlet (n.d.) Retrieved from http://quizlet.com/ Screenshot by author. The various types of flashcard use available on Quizlet

Once a user has a study set, they are able to use them for a variety of activities shown in figure 7, Quizlet Activity Bar. These various forms of testing allow for a variant amount of difficulty in the exercises. However, as all questions and answers are provided by users, the difficulty of the questions and answers remain linear with only the presentation of questions and access to help changing. For example, while in the flashcards activity, users are freely able to flip cards from question to answer. This can make it easier for a student to quickly check their knowledge without requiring an answer. This does not guarantee the student is practice testing themselves as they never explicitly commit an answer.

Other ways of using flashcards on Quizlet offer more explicit practice testing, such as the Learn activity. In the Learn activity, students progress through rounds providing an answer chosen from a set of four multiple-choice options. This forces students to make a decision, which is then revealed as true, or if not, which answer was.

Another study type available is the writing activity, which hikes up the difficulty by requiring a typed answer. Users can override the system to say they were correct if they miss the spelling or something similar, but by requiring an answer, this is a great way to actively study. Additionally, if a user provides the answer of another flashcard, they are notified of a confusion alert, which helps aid in understanding where the answer provided came from.

The spelling activity asks users to listen to an audio prompt, either question or answer, and type what they hear. This is an interesting application of dual coding, and allows for users to hear their own questions asked to them.

Last of the study exercises is the Test activity, which generates a brief test containing questions and answers from the study set. This activity does not immediately respond with correct/ incorrect when answering questions, and instead waits for submission. As such, this is a more difficult practice testing method than the others.

Across activities, users' answers are recorded, and are presented on the study-set's homepage, making clear which questions and answers a student is struggling with or otherwise. Through these various testing methods, Quizlet offers the most comprehensive testing package of any user-content provided flashcard tools I examined.

Quizlet Gamification

Despite being a comprehensive package, most of Quizlet's study activities themselves have little gamification past their feedback and progression. This is perhaps a result of

Quizlet relegating its gamification to its *Play* section. Of the seven activities available, only Match and Gravity are marked as play rather than study, and provide further examples of gamified study.

Match and Gravity are different applications of gamification than what has been described in this paper thus far. They are more traditional games, but I believe they still gamify study by reframing how the flashcard questions and answers are interfaced by users. As such, I believe including these alternative forms of gamification, however close to traditional games they may be, among the described gamification methods.
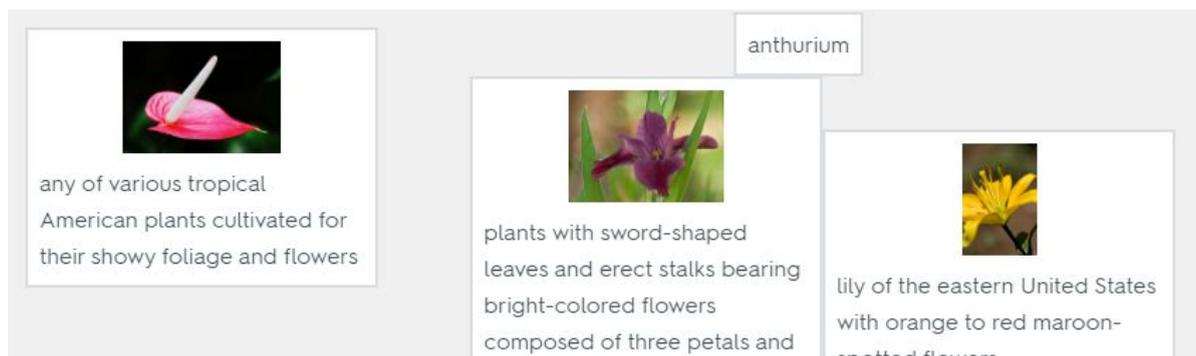
Quizlet Play-Study Matching Study-Game

Figure 8. Quizlet (n.d.) Retrieved from http://quizlet.com/ Screenshot by author. Quizlet's Match game prompts users with their flashcards and times their matching skills

Match is the first of two gamified study activities, tasking users with dragging one part of a question/ answer pair onto the other. Completion time is tracked, and can be compared against others on a leaderboard, and one's own best time as per Figure 9., Quizlet Post-Matching Game Leaderboard.
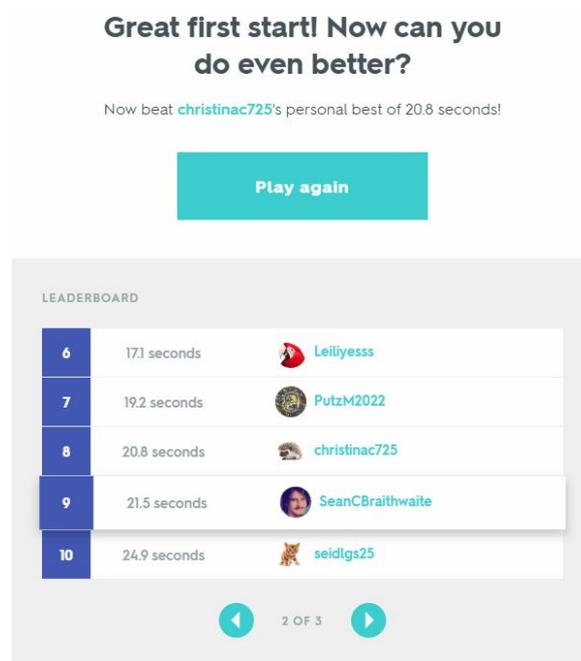
Quizlet Post-Matching Game Leaderboard

Figure 9. Quizlet (n.d.) Retrieved from http://quizlet.com/ Screenshot by author. Match's post-round lobby encourages players to beat other players' scores and improve their time.

Gravity is Quizlets other play-study activity, which tasks players to answer questions displayed on asteroids before the collide with your planet. It's a simple type of gameplay, supported by a score and level. Before beginning, there is also a configuration where students can select whether they want to see questions or answers on the asteroids, and at what difficulty they would like to begin.
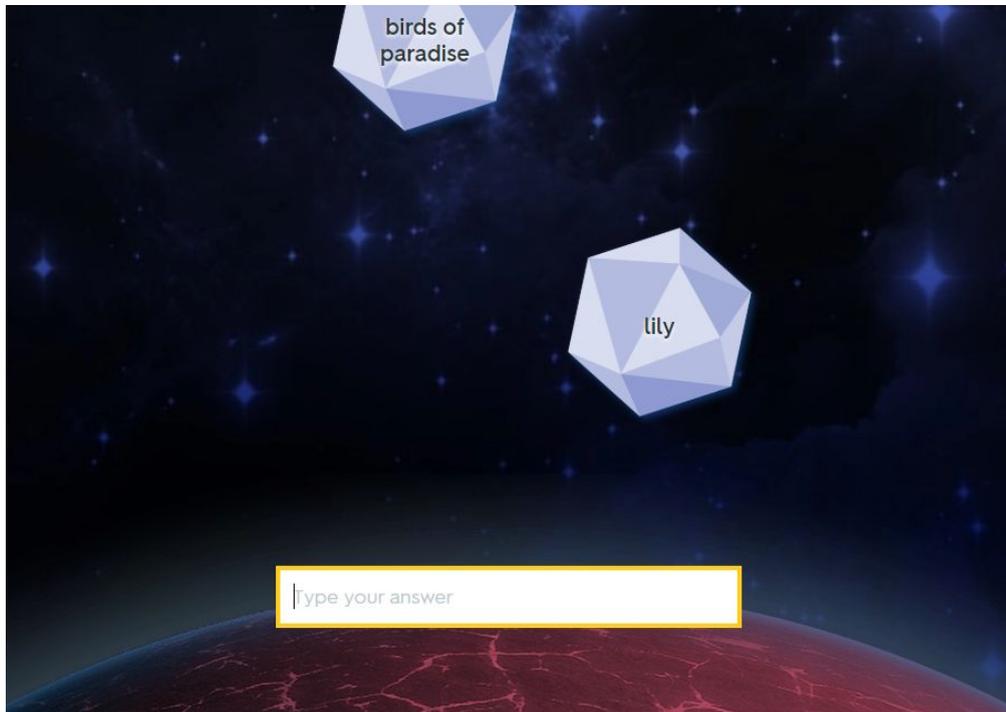
Quizlet Gravity Study-Game

Figure 10. Quizlet (n.d.) Retrieved from http://quizlet.com/ Screenshot by author. Quizlet's Gravity game pits players against oncoming asteroids which must be destroyed by typing the correct answer.

Other Gamification and Study Elements

In addition to Duolingo and Quizlet, a number of smaller flashcard-testing services exist, each with their own unique implementations of the elements of effective study, and gamified flashcard study. Among these, there were services which offered gamification only as incentivization, where a single play of a game would be provided for answering an ever-increasing count of provided questions. The experience studying on those sites was akin to an arcade machine, but instead of coins it was questions. The gamification was mixed with the learning like oil on water, and was more disruptive than beneficial.

Alternatively, there were also a number of services which offered subtler gamified play more similar to that of Quizlet. These services, such as Study Stack, provided the user with a number of ways to express their flashcard questions and answers, including crosswords, hangman, and other word games.

A final noteworthy example was found on MemRise, another language-learning service similar to Duolingo. Interestingly, MemRise offers a 'Mem' feature which is used to create a visual mnemonic for aiding in the recall of vocabulary. It allows users to create these mems for questions, as in figure 11., which can later be used if the phrase appears again. This was the most interesting and direct application of visual mnemonics, with its tutorial even suggesting the use of wild imagery as per the Von Restorff effect.

Memrise Mem Creation Prompt
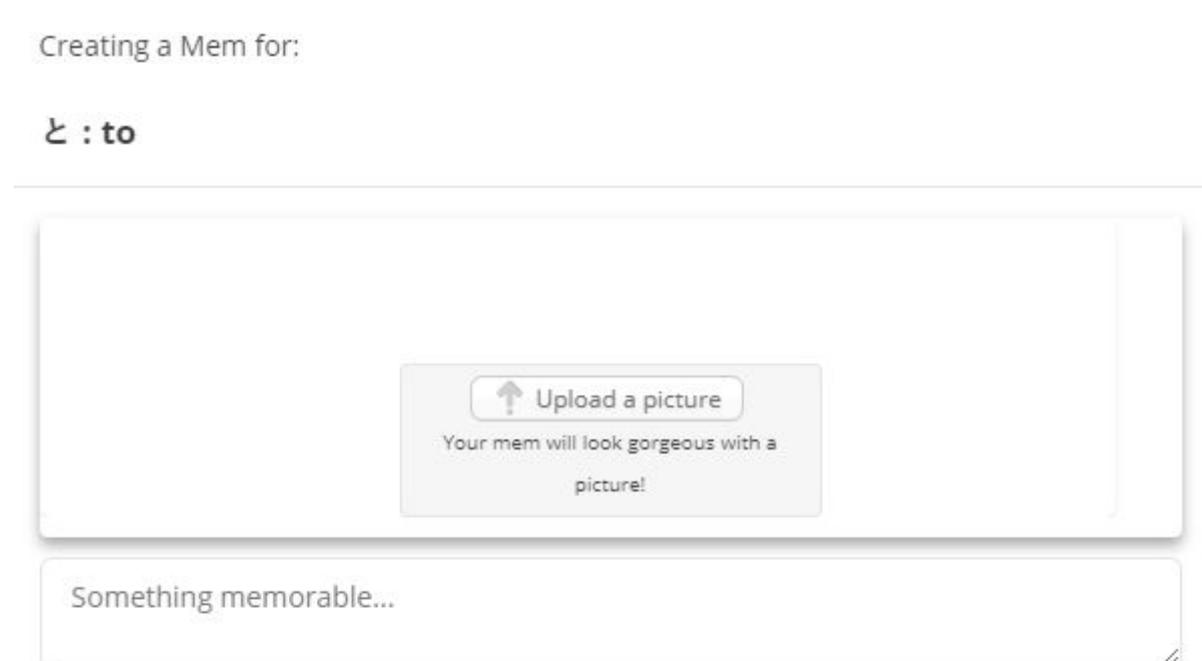
Figure 11. MemRise (n.d.) Retrieved from http://www.memrise.com Screenshot by author. Creating a 'Mem' on MemRise is the most explicit mnemonic-creating tool analysed.

Across all the examined services, Duolingo offered the most comprehensive gamification, while Quizlet offered the most broadly-applicable interface and methods of study. In addition to the two major study-services covered, a number of lesser-known and play-focussed examples were looked at, including MemRise, BenchPrep, Study Stack, Flashcard Machine, StudyBlue, Flashcard Stash, Memorize, SuperMemo, Cram, Tinycard, AnkiDroid, ClassTools, Study Jams, and Review Game Zone. Each of these services offered their own forms of flashcard study, gamified or not.

Each service examined offered some type of testing. Some, such as Quizlet and Study Stack allowed for users to create generative quizzes and activities based on their flashcards. These were gamified by providing players with lives, performance scores, and leaderboards for those scores.

Quizlet's services offer excellent study tools, and simple games to practice recall with. However, I believe Quizlet misses out on opportunity to gamify their general service and interface, especially considering their use of user-made content emphasizes individuals' own motivation. Something like a level system or daily-return bonus would surely encourage users' daily study.

Distributed practice was encouraged through a variety of ways, and was shown through returning or daily study. Duolingo showed clear interest in this with streaks for return study, progression systems, currencies tied progression, and purchasable goods that extend other systems. Players can purchase additional courses, such as flirting, which are non-essential yet highly desirable, and place wagers on their continued daily study. This was the most heavily-backed aspect of study by Duolingo. No other service examined offered return rewards to users.

Mnemonics were afforded by a number of the services, ranging from the ability to add images and custom text to flashcards, to mnemonic-specific functionality such as MemRise's *Mem* feature. Mnemonics were not gamified in any examples found.

Difficulty was gamified across a number of the services, with Quizlet's gravity mode offering difficulty selection, and both Quizlet and Duolingo offering various ways to frame the questions and answers being asked.

Lastly, dual coding was present across several of the services. Duolingo has pronunciation exercises and will speak to the user, as with Quizlet's Spell activity.

Play-Based Flashcard/Q&A Interfaces

The question and answer format which flashcards take advantage of is not unique to study. Classic games such as Trivial Pursuit, Pictionary, and Jeopardy also ask their participants to answer some form of question before a set answer is revealed. Though these titles were not focussed on education, they can be readily reframed to do so.

In recent years, Jackbox Games has released a significant number of games which adapt the question/ answer format creatively, including Drawful 2. In Jackbox's Drawful 2, up to 8 players are provided a prompt to which they draw an image, and then later prompted with the drawn images and try to guess what it is amongst other players' false claims. Players are incidentally forming image mnemonics, with players often drawing wild images and players associating memorable phrases with them. Drawful 2 even supports the creation and distribution of questions, making it a potential studying tool as is.

Proposals of gamified study systems for Duolingo and Quizlet

Having analysed a variety of flashcard services and their implementations of gamification, there is opportunity to make recommendations for new and existing systems. These recommendations are based upon the above descriptions of effective study techniques, how the investigated services implement them, and my experience gamifying education.

Distributed Practice, Progression, and Quizlet Study Sessions

One element which Duolingo doubled-down on was distributed practice, which it encouraged through progression schemes, rewards for performing daily study, and its streak systems. These systems encouraged users to sequentially return and got them studying by only providing daily reward by doing so. Importantly, users must use the study services for this to be useful, rather than merely log-in for reward. Surprisingly, these gamified elements encouraging distributed practice were not present in any of the other services examined, including Quizlet. However, Quizlet has a lot to gain from encouraging distributed practice, but it would need to do so differently from Duolingo. Duolingo was able to implement progression schemes as they provide the curriculum, and in learning language there are more defined bricks to build progression with. Quizlet, however, falls prey to its greatest strength in this area, breadth, as designers cannot readily know what users will be doing at a time.

To provide a progression scheme for its users, Quizlet could implement a generic levelling system. However, this in and of itself would likely do little to create appeal. Instead, the progression already shown in quizzing review could be shown alongside the topic on the dashboard, visible when users initially log-in. This would allow students to immediately see progress on their dashboard, not unlike collectables found in a game level, and readily compare topic progression.
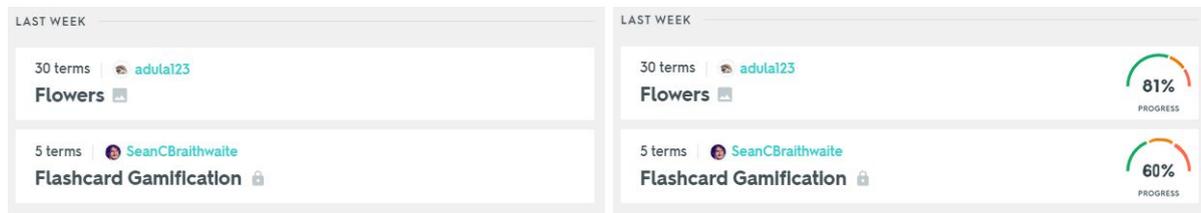
Quizlet Study Dashboard and modification

Figure 12. Quizlet (n.d.) Retrieved from http://quizlet.com/ Screenshot by author. Present dashboard displayed on login, showing recent study sets versus edited, showing progression.

Memorize By Goals

There are also other potential ways both Quizlet and Duolingo could gamify to encourage distributed practice. For example, if users could set a 'memorize by' goal, which encourages them to return to study on a topic and master it before a certain time. This goal would be similar to the bets users can make on Duolingo to double their Lingots if they study a number of consecutive days. Extending that, if Quizlet itself provided a schedule of study times and test times, students would be able to set aside specific times to study. These schedules could be based on an account-general availability spread, or leverage research into how best to distribute practice, as with the SM-2 formula.

Notably, some students may not care to follow along with a self-imposed schedule, so further incentivizing their return with other overarching systems as per Duolingo, such as an account-wide score and leaderboard amongst peers could provide value. Presently, Quizlet offers leaderboards for its play-section activities, which are exclusive to each study set. Simply compiling these scores and showing them on the dashboard page alongside a leaderboard would encourage competition amongst peers, encouraging return testing.

Classrooms and Communities

Another aspect yet underexplored is that Quizlet is used by so many American high-school students, yet there is no way to group students with similar focusses. If Quizlet were to offer class-study networks or other 'focus' social networking capabilities, peers could have greater access to those of their community. These communities can then be used, for example each students' progression could be shown and contribute towards a cumulative class goal. These classes and communities systems could implement study times and goals as previously mentioned, and would provide a platform for greater study-interactivity between peers, which in and of itself sources a number of gamifiable opportunities including competitive and cooperative study, something presently non-existent with the analysed services. These groups could even have their own leaderboards and memorize By goals.

Classroom Mnemonics

Presently, Quizlet's selection of play activities includes two play activities, one for matching and another for typing answers under time constraint. Each of these focusses on retrieval speed of individual cards, rewarding knowledgeable players' quick recall. These games don't focus on building new connections, chunks, or sequencing. This leads to a question: What would a game whose goal was to create connections look like?

A way to create these could be done similarly to Drawful 2, allowing players to collectively create associative imagery around either sequencing of chunks, or individual questions. Players could then choose from the images the one which aids their study most, and points could be provided to the creator as such. This would be a great way to guide a class in contributing towards a common goal.

Conclusion

How might flashcards be gamified to improve their study effectiveness? First, to understand how effective study is performed, five elements of effective study were defined, including practice testing, distributed practice, chunking/ sequencing, dual coding, and image mnemonics. With Duolingo and Quizlet as case studies, these elements' implementation and gamification was examined, finding a number of strengths and weaknesses across each study. The gamification of flashcards has much room to grow, with proposals on ways to create communities and goals which support new types of study and play. It is these inventions and creative reframings of existing media which will pave the crossroads we now find ourselves at, carving a wider pie for all, with unimaginable benefits to education. Going forward, proper testing of these gamified elements' effectiveness is required for conclusive statements, but those are beyond the scope of this deepdive.

The examples of and proposals to improve Duolingo and Quizlet's systems barely scratch the surface of the untapped gamification potential for those services alone. As per their prevalent usage, flashcards are an effective interface for presenting questions and answers, and their encapsulated form makes them effective for reframing and coupling with other interfaces. This encapsulation makes the flashcard format malleable and transferrable. As a result, there are many ways to gamify flashcards and education yet to be seen, and countless ways to improve study effectiveness.

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