

Enhancing Exam Prep with Customized Digital Flashcards

Susan L. Murray Julie Phelps

Missouri University of Science and Technology

Hanan Altabbakh

American University of Kuwait

Abstract

It is common for college classes to contain basic information that must be mastered before learning more difficult concepts or applications. Many students struggle with learning facts, terms, or fundamental concepts; in some situations, students are even unsure about what they should study. Flashcards are a well-established educational aid for learning basic information. Software programs are available that can generate flashcards electronically. This paper details an evaluation of the benefits of online flashcards. An undergraduate engineering class used digital flashcards which were developed using off-the-shelf software. Students showed an interest in using flashcards in their current class and a willingness to construct new ones for future classes. Students also were not aware of how useful flashcard utilization was in their learning process, and it was rare that they used them in other classes.

Introduction

Flashcards are an educational aid for student memorizing information. Typically, they consist of stackable paper used to practice test-taking. The principle of using flashcards is the spaced repetition to build permanent memories of important material. Studies have proven that spaced study is more effective than mass study (Augustin, 2014). Studying a large stack of flashcards in a spaced pattern is more effective than piling up the material to be studied, in mass, only minutes before exams (Kornell, 2009). Spaced learning results in more long-term learning than mass learning (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006).

The goal of using flashcards is to self-test one's knowledge of specific material. Additionally, creating flashcards encourages learning by doing, through the synthesis of information as well as the opportunity for peer review when the flashcards are shared. Moreover, utilizing flashcards as a learning technique encourages formative assessment, self-identification of misconception, and improve memory retaining (Colbran, Gilding, & Colbran, 2014).

Flashcards are traditionally constructed with paper index cards; questions are written or typed on one side of an index card, and the solution is on the other. Digital flashcards can simulate this design. They can be viewed at different speeds for better-spaced repetition application. Showing the next card at the proper timing ensure the appropriate lags between sessions or within the cards themselves (Pham, Chen, Nguyen, & Hwang, 2016). There are other advantages for students using digital flashcards. They are easy to share or post online. Easy storage is another advantage since they can be reviewed on a smartphone or tablet anywhere. Traditional flashcards are harder to share and inconvenient since they can be lost or damaged easily by wear and tear. They are also less environmentally friendly. One potential disadvantage is that digital flashcards need more expensive equipment (computer, mobile phone, or tablet) compared to pen and paper. However, the vast majority of students already have access to these devices. Digital flashcards can require less time than traditional flashcards in writing, editing, or sharing.

Literature Review

Research has shown that repetitive testing using flashcards is a more effective learning strategy than repetitive studying for short-term knowledge retention in clinical medical students. The same study also determined that students are unaware of the greater impact of the testing strategy (Schmidmaier, Ebersbach, Schiller, Hege, Holzer, & Fischer, 2011). Another study was performed on university students to prove the effectiveness of digital flashcards on the final written examination when comparing technology enriched vs. traditional classroom instruction (Eads & Hamson-Utley, 2014). Also, practice testing and distributed practice received high utility assessments in a study that investigated ten different learning techniques and their effects on students. The study recommended practice testing, including using flashcards, as it assists learners of different ages and capabilities and enhances their performance among many education contexts (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013).

Wissman, Rawson, and Pyc (2012) showed that students have limited knowledge of the benefit of using flashcards in their learning process. The study revealed that 83% of students reported using flashcards to learn vocabulary, while 29% used them for key concepts. The study finds that students would significantly benefit from flashcards if they extend their application to a broader variety of learning objectives. The same study also revealed that few instructors recommend using flashcards as a learning strategy in their courses. The study finally suggests that instructors should be educated about the benefit of self-testing, factors that influence the efficiency of self-testing, and ways to integrate self-testing methods into the curriculum for the teacher training program (Wissman, Rawson, & Pyc, 2012).

Method

A required sophomore-level engineering class, Operations Management, was used to evaluate digital flashcards. Students enrolled in the course were offered extra credit for making digital flashcards; the majority (91%) chose to participate. The goal of this project was to explore engineering students' willingness to develop and use digital flashcards. The flashcards created by the students were embedded in the class's learning management system webpage (specifically Blackboard). The digital flashcards could be reviewed in a variety of formats and from laptops, computers, and smartphones.

An example of digital flashcards is shown in figure 1. The top flashcard is for initial study; the term and its definition are shown to the student at the same time. The second flashcard format is used for self-testing. The student reads and answers the question or provides the appropriate term; then the digital flashcard can be "flip" showing the correct answer. Sets of cards from different topics or textbook chapters can be combined and shuffled. The free Web tool Quizlet (<http://quizlet.com/>) was used to create the digital flashcards used in this study.

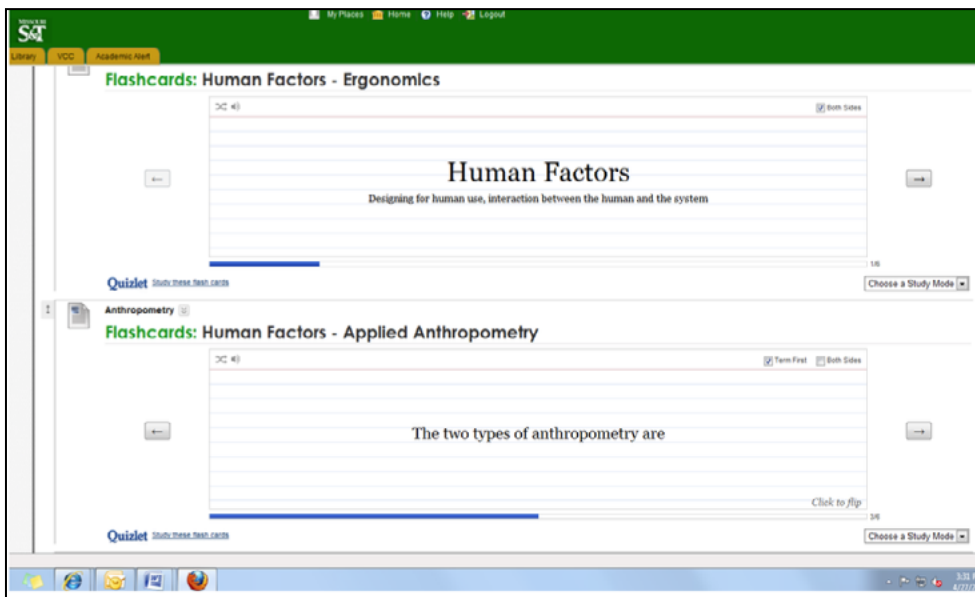


Figure 1. Sample Digital Flashcards

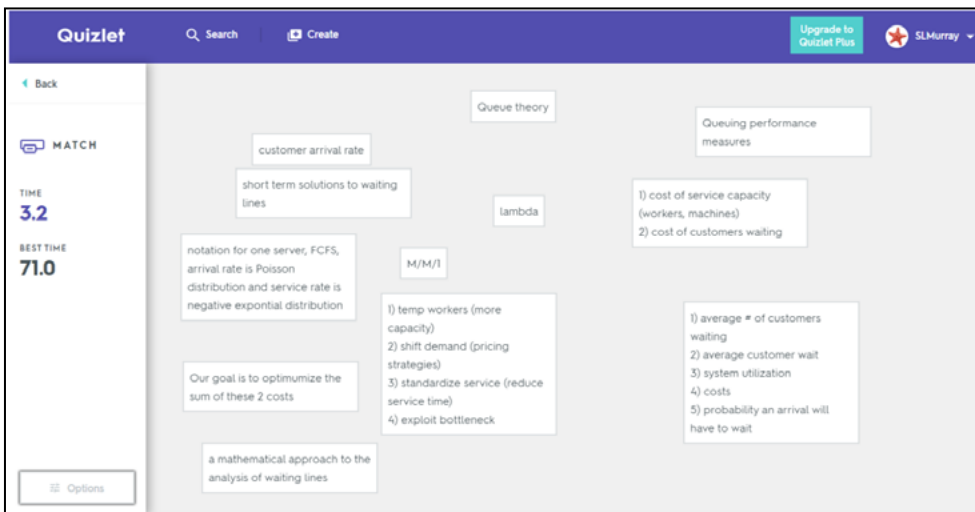


Figure 2. Sample Matching Exercise

Study Method	Typical Class
Review PowerPoint slides or class notes	23 (100%)
Review homework assignments	21 (91%)
Make notes or flashcards	12 (52%)
Read textbook	12 (52%)
Study with classmates	12 (52%)
Other (old exams)	3 (13%)
Make sample questions	1 (4%)

Figure 3. How Students Study for Exams

The material can also be presented in other formats such as matching exercises. Figure 2 shows a set of digital flashcards with both sides of the cards displayed. Students

race to drag the terms to the matching definition. Incorrect matches are displayed in red, while correct matches disappear. A clock times the student as he or she clears

the screen. Feedback comparing the time required to the student's best time and their position on a class leaderboard is given at the completion of the matching.

Procedure

After the final exam, the students were anonymously surveyed about creating and using digital flashcards. The survey began with questions concerning how the students typically studied. Students were also asked to compare this specific class to a typical class; this was done to provide a basis for comparison to see if students studied differently with the introduction of digital flashcards and to assist in determining the ease/benefit of generalizing the study's findings to other courses. The students who made digital flashcards were asked rate both how useful it was to make flashcards and how useful it was to review the flashcards.

Determining the key material to include in a flashcard was expected to provide the students with an opportunity to prioritize and review study materials. Using the flashcards for review would also provide the students with a different learning opportunity to memorize facts and concepts. We sought the students' perspective on both of these potential benefits. The next portion of the survey explored the ease of use of the software to create the digital flashcards and the ease of viewing and using the flashcards on different types of devices.

We also explored whether the students' experience with digital flashcards would influence students' study techniques in the future. Students rated the likelihood that they would use digital flashcards in future classes after having used them in this class. Finally, the students received an email from the instructor a year later to see what if any experience they had with digital flashcards since this particular class.

Findings

An anonymous electronic survey was sent to all of the students in the class before the introduction of digital flashcards. The response rate was 95%, and the sample size was 23 undergraduate students. In the survey, students self-reported studying an average of 5.8 hours for an exam; the mode was 4.0 hours. The students were asked the various methods they used when studying for an exam. Figure 3 summarizes the responses. Students were able to select more than one study method. Making notes or flashcards was a common method of studying.

During the course, the idea of building digital flashcards was introduced to the students. The majority of the students in the class participated in building a set of flashcards for the material in various textbook chapters. The flashcards were reviewed and edited by the instructor and then made available to all of the students in the class in preparation for a mid-term and final exam. The

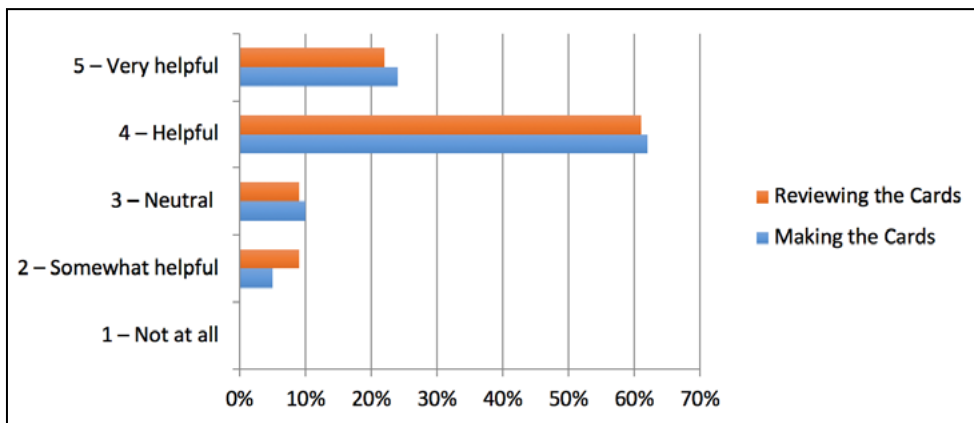


Figure 4. Flashcard Usefulness

1 Time	2 Times	3 Times	4 Times	5 Times or More
2	7	8	2	3

Figure 5. Frequency of Digital Flashcard Usage

How often do you use paper flashcards to study for an exam?				
Never	Rarely	Depend on Class	Often	Almost Always
6 (27%)	8 (36%)	5 (23%)	2 (9%)	1 (5%)
How likely are you to make digital flashcards for another class?				
Will Not	Not Likely	Don't Know	Somewhat Likely	Very Likely
0 (0%)	3 (14%)	2 (9%)	11 (50%)	6 (27%)

Figure 6. Students' Use of Flashcards

student received an anonymous online survey about digital flashcards. The survey asked "How useful was making a set of cards for learning the material in the chapter?" on a five-point scale. Students who did not make flashcards skipped this question. The students who used the digital flashcards to study, were asked "How useful was reviewing the sets of cards for learning the material in the chapter?" Figure 4 shows the responses to these questions. Both the process of making digital flashcards and reviewing them were rated "helpful" or "very helpful" by over 80% of the students.

The students were surveyed about their approach to using digital flashcards and the ease of use of the software. The students could view the flashcard in three locations. The first was embedded in the course's website which also housed PowerPoint slides used by the instructor, homework assignments, and grades. Quizlet.com, the site used to create the flashcards, was the second location students could view the flashcards. The final location via a free app available on smartphones or other devices. This method of accessing the digital flashcards allowed students to study on their phone or handheld device anywhere at any time.

Students were asked to report all of the ways they accessed the digital flashcards. Eight (35%) viewed the cards

on the class website. The location would be convenient since most students visited the class' website multiple times per week to check their grade or view class materials. Seventeen (74%) used the flashcard software to view the cards. Since the majority of students in the class had created flashcards, they were familiar with the software and had easy access to it. A smartphone was used by six (26%) of the students. In the comment section, one student said that he or she did not have the appropriate phone to view the flashcards. The responses total to greater than 100% because some students used more than one viewing method.

Students were asked to rate the ease using the digital flashcards on a five-point scale. Seventeen students rated it "easy," and four rated it "somewhat easy." Only one student rated it as "somewhat difficult." An option to provide an additional comment was provided; the only comment made was "hard to change sets, would like if they were compiled into one set." The cards were developed and organized by textbook chapter. This provided flexibility in choosing topics when studying.

The students were asked how often they reviewed the flashcard sets. Their responses are in Figure 5. The most common answer was two or three times.

We also asked how the students would study in fu-

ture classes. The students were asked "How often do you use paper flashcards to study for an exam?" and "How likely are you to use Quizlet (or some other online tool or app) to make digital flashcards for another class?" Figure 6 presents the survey responses; 63% reported "never" or "rarely" using flashcards to study for an exam. As second or third year engineering students, the types of courses the students are taking may have less required memorization and be less suit for flashcards. However, when asked about the likelihood of using digital flashcards for another class 77% answered either "somewhat likely" or "very likely."

Comments received on the survey included "I found it very helpful as a review tool for the exam and wish I knew about it sooner; much easier than handwriting flashcards." Multiple students commented that they did not use traditional flashcards because of the time required to create them. One student reported a preference for the traditional paper format instead of reading off a screen.

Follow-up Survey

A semester and a half later, the students were asked in an email from the instructor if they had used digital flashcards in other classes. Only seven students (30% response rate) responded. One had made digital flashcards for another class, and two had made traditional paper flashcards. The remaining four students still liked the idea of digital flashcards, but either did not find the time to make them or did not think they would be beneficial for upper-level engineering courses. Caution should be exercised before drawing conclusions from this limited sample.

Conclusions

This study provides insight into the methods students use to prepare for exams. Having the flashcards prepared by the students resulted in inconsistent format and quality to the cards. The instructor needed to spend time editing the cards before providing them to the entire class. Some concepts selected by the student building the digital flashcards were considered by the instructor to not be significant enough to justify a flashcard. In other cases, students overlooked important concepts and the instructor needed to add flashcards. The students were receptive to using the cards even if they did not participate in preparing them. The digital flashcards were popular with the students. The instructor has made some modifications to the flashcards and continued to provide them to students. As more textbooks move to electronic formats, publishers could make this type of study material easily available to students.

Using electronic flashcards with today's handheld devices provides students with the means to study anywhere at any time. Frequent, short review sessions are an effective method of reviewing and memorizing educational materials. Students in this study were receptive to using electronic flashcards both during their initial introduction to this study aid and in the follow-up survey.

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Susan L. Murray, Ph.D., is department chair and professor of psychological science at Missouri University of Science and Technology. She also has an appointment as professor of engineering management and systems engineering. Her research and teaching interests include human factors, safety, and engineering education. This article is a result of her strong desire to help students excel in their education. Before her academic position, Murray worked in the aerospace industry, including two years at NASA's Kennedy Space Center.



Julie Phelps has been an instructional designer at Missouri University of Science & Technology since 2010. As the team lead of Instructional Design & Development, she assists faculty in course design and technology implementation. She holds an M.A. in Information and Learning Technologies from The University of Colorado-Denver and a B.S. Ed. from The University of Missouri, Columbia.

From 2001–2010, Julie was an instructional specialist for The eMINTS National Center providing professional development to K-12 teachers throughout Missouri. Prior to eMINTS, Julie taught elementary grades in Missouri, Texas, and Colorado over a span of 17 years.



Hanan Altabbakh, Ph.D., is an Assistant Professor of Systems Engineering at the American University of Kuwait (AUK). Previously, she was the assistant program manager of the Science and Math Education Program at Kuwait Foundation for the advancement of sciences. Prior to that position, she worked for Kuwait's Ministry of Education as a Lead Industrial Engineer. Dr. Altabbakh holds both Masters and PhD. degrees in Engineering Management from Missouri University of Science and Technology. She earned her Bachelor degree in Industrial and Management Systems Engineering from Kuwait University. Additionally, Dr. Altabbakh holds graduate certificates in Lean Six-Sigma, Project Management, and Human-System Integration.

