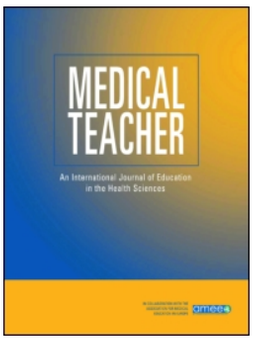

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TWELVE TIPS

Twelve tips for medical students to establish a collaborative flashcard project

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ABSTRACT

Medical students employ various study strategies to master large amounts of information during their medical education. Digital flashcards are an interactive, self-directed study stool that may improve knowledge retention by combining the principles of active recall and spaced-repetition. They may be studied during and beyond undergraduate medical education. However, making flashcards can be an onerous task. In this article, we describe twelve tips on how to establish and maintain a collaborative digital flashcard project based on the undergraduate medical curriculum.

Introduction

Undergraduate medical education involves a demanding curriculum with the expectation that learners master large amounts of information. Various study strategies are commonly employed by medical students to achieve this task, including: note taking, rote memorization and others (Augustin 2014; Saeidifard et al. 2014; West et al. 2014). An alternative method proposed to improve knowledge retention is the use of digital flashcards. These incorporate the principles of active recall and spaced repetition. Unlike recognition memory, which involves identifying an answer based on familiarity (Manns et al. 2003), active recall requires that a learner accurately retrieve the answer. Spaced repetition involves repeated exposure to the same prompt over increasing time intervals. Numerous studies have demonstrated that these principles are effective for improving long-term memory recall (Morris et al. 2005; Kerfoot 2010; Storm et al. 2010; Dobson 2012; Taveira-Gomes et al. 2014).

Digital (electronic) flashcards may serve as an excellent platform for studying the medical curriculum (Ruiz et al. 2006; Taveira-Gomes et al. 2014). The digital-nature allows flashcards to be easily updated and edited according to the newest clinical evidence and guidelines. Many free flashcard software applications are compatible with different operating systems and devices, thereby permitting users to study anywhere they take their devices. Lastly, digital flashcard creation and editing are team-friendly responsibilities that can be divided amongst a number of students, fostering collaboration and lessening individual workload (Bow et al. 2013).

An instructional guide on how to establish and maintain a collaborative digital flashcard project based on the undergraduate medical curriculum has not been previously published. Herein, twelve tips are presented for implementing a student-run collaborative flashcard project using free software and a file share service, with the aim of improving knowledge retention during undergraduate medical education.

Tip 1

Succeed with collaboration

Collaboration is critical for success in many educational endeavors, including creating digital flashcards. The most immediate advantage in a collaboration of this nature is the time saved by dividing the creation of the digital flashcards. A variety of educational backgrounds among members is another advantage that can be leveraged to strengthen the quality of the study material. A benefit of collaboration is the social environment, which may include support systems, open-mindedness, and an encouraging atmosphere (Laal and Ghodeshi 2012).

In contrast, some may be deterred by the reliance on other classmates for task completion in a timely and accurate manner. Despite the best intentions of all participants, collaboration is a human endeavor: deadlines may be missed; and, not all digital flashcards are created equal. As a result, it is helpful to use a spreadsheet to organize assignments and schedule deadlines (*see Tip 4*). Additionally, establishing clear expectations with respect to flashcard content and formatting can mitigate inconsistencies during card creation (*see Tip 7 and Tip 8*).

Tip 2

Target curricular content

Many medical schools have undergone pre-clerkship curricular reform. They have moved away from traditional lectures to approaches which emphasize early mastery of biomedical sciences, predominantly via classroom didactics (Roberts et al. 2003; Mahan and Clinchot 2014). The reformed curricula are less lecture-centered and incorporate tutorials, seminars, and self-directed learning. These modalities are meant to complement course material and promote deeper learning through problem-solving, application of knowledge and skills, and student discussion

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(Azer et al. 2013). Given the diversity of curricula at various institutions, members of a flashcard will need to address each of the various curricular components they intend to use for their flashcard content.

Tip 3

Establish roles and responsibilities

Establishing roles and responsibilities will allow members to coordinate project implementation and maintenance. Three instrumental roles are project lead, workload manager, and error manager. The project lead takes on the responsibility of representing the project to fellow classmates and faculty. This may include arranging meetings with members of the project and once the project has evolved, developing a mentorship program for new members (*see Tip 10*). The role of workload manager takes on the responsibility of creating and maintaining a spreadsheet to keep track of assignments, deadlines, and peer reviews (*see Tip 4*). The error manager takes on the role of correcting erroneous material on flashcards, because despite peer review, errors inevitably occur. All members can help the error manager by notifying them of flashcards with errors, for correction and dissemination to the entire group.

Tip 4

Organize the workload

Members can benefit from using a shared system for organizing and monitory their workload, such as spreadsheet. This system should contain enough information for members of the project to easily identify their assignments.

For instance, including identifiers of curricular content, such as the lecture title and number is helpful for coordinating assignments among members. Additionally, including separate columns on the spreadsheet for creating and peer-review roles, clarifies the nature of each assignment. These columns can also be used to keep track of the degree of member contribution to the project and will thus provide an honest account of workload distribution. Including the date of the curricular activity allows members to plan their schedules accordingly in order to ensure timely completion of their assignment. Establishing due dates may prevent delays in the delivery of content to the group. Including a status bar for flashcard deck creation and editing (e.g. "not started", "in progress", and "complete") reinforces this notion.

Tip 5

Choose flashcard software

Digital flashcards are very easy to share, create, and transport compared to traditional paper flashcards. There is a variety of digital flashcard software platforms and each is slightly different. Examples include: Anki, Cram, OpenCards, Osmosis, and Quizlet (Table 1). An examination of multiple software options revealed that each program is unique and has its own strengths and weaknesses (Nakata 2011).

Flashcard software should be selected to best meet the needs of the project. It is desirable to select flashcard software that is compatible with various web-based, desktop, and mobile applications in order to accommodate members' operating system preferences (Table 1).

In one study, a number of medical students developed a flashcard project with their own software, which crowdsourced flashcard creation to their classmates (Bow et al. 2013). The authors report that students were comfortable using this software because it was simple, integrated with familiar software, and functioned offline. However, as others point out (Deng and Gluckstein 2014) and the authors later concede (Bow et al. 2014), the crowdsourcing platform lacked a spaced repetition system. This is notable because testing using spaced repetition improves long-term retention (Dobson 2012). Therefore, we strongly recommend that those interested in establishing a collaborative flashcard project consider flashcard software which incorporates this element.

Tip 6

Create digital flashcards

Most flashcard software feature basic, cloze-deletion, and image-occlusion flashcard types. A basic flashcard is similar to traditional paper flashcards; it contains a full-uninterrupted question, with an answer that is revealed entirely at once (Figure 1). A cloze deletion card contains word(s) that are hidden from the surrounding text by a placeholder (i.e. "clozed") and must be actively recalled before being revealed (Figure 2). Image-occlusion flashcards are similar to those featuring cloze-deletions. However, user-defined portions of an image are obscured with labels. Answering the card reveals the obscured parts of the image (Figure 3).

A basic flashcard is well suited to contain text. Conversely, a question which asks for the differential diagnosis of a particular disease process requires recall of a list. A cloze deletion flashcard is well suited to prompt recall of items within a bulleted list, and in some software can include prompts, such as mnemonics.

Table 1. Examples of flashcard software and their features.

	Anki	Cram	OpenCards	Osmosis	Quizlet
Cost	Free, except iPhone app$	Free	Free	Free trial$–$$$	Free version
Platforms	Mac/ PC/ Linux/ Web/ App	Web-platform/ App	Mac/ PC/ Linux	Web/ App	Web/ App
Editing	+	+	+	+	+
Spaced-repetition	+	–	+	+	+
Import images	+	+	+	+	+

$ ≤ $40 CAD; $$$ ≥ 90 CAD

Tip 7

Frame digital flashcard content

After deciding on the card type, it is important to decide how to frame the question and answer stem. Sufficient context needs to be provided in order to orient the user and avoid "Guess what I am thinking?" type questions. Similarly, multiple choice question stems are not recommended because they may facilitate memory of false answers (Smith et al. 2013). Therefore, question and answer stems should be written as concisely and clearly as possible to permit rapid recall of key information during studying.

Learning and recall during studying are dependent on an individual's working memory, which is hindered by the inherent cognitive load of the task (Young et al. 2014). For digital flashcards, cognitive load refers to the number and relatedness of tested concepts, presence and amount of distractors, and inherent difficulty of the question. For instance, medicine is full of helpful mnemonics that can be easily incorporated into digital flashcards and are oftentimes helpful to organize and connect listed concepts. However, posing a number of separate questions about a disease process within a single question stem may interrupt momentum and overwhelm working memory when studying. As such, the group should agree upon an acceptable range of tested concepts per question stem. The same concepts apply to answer stems with the exception that it can sometimes be helpful to include embedded references, thus allowing users to expand their knowledge on the topic(s).

Tip 8

Format digital flashcard content

The objective when formatting digital flashcard content is to enhance the clarity of the concepts within the question and answer stems (Figure 4). One useful approach is to divide tested concepts within a question stem into paragraphs separated by a blank line, as this empty space has been shown to modestly improve reading speed and accuracy (Bernard et al. 2007). Similarly, formatting the font of keywords will make them stand out from the larger concept. This can be accomplished using text that is colored, bolded, italicized, and/or underlined. Making these minor changes will help to reduce cognitive load and maximize legibility (Kahneman 2011).

Tip 9

Share digital flashcards

Sharing digital flashcard decks among members is an integral part of operating a successful collaborative flashcard project. All members with an internet connection can access flashcard decks through the use of a cloud storage service. Such storage services allow an unlimited number of

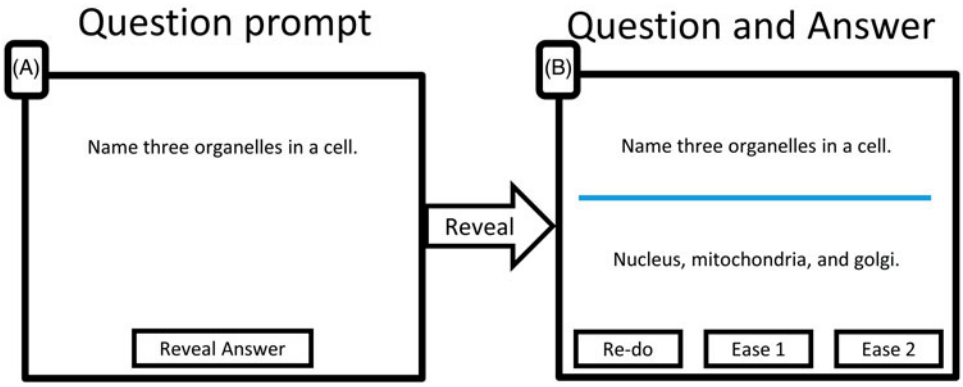

Figure 1. Example of a basic flashcard testing on three organelles in a cell. A) After actively recalling the answers the user presses the reveal answer button to test their accuracy B) The clozed stems are revealed and the user provides feedback to the software regarding if they actively recalled the correct answer and how easy it was for them (Re-do, Ease 1, and Ease 2).

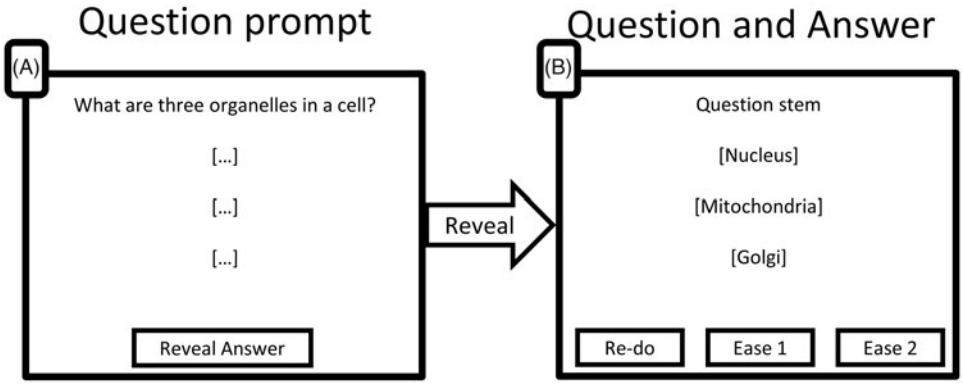

Figure 2. Example of a cloze deletion flashcard with three testing prompts. A) After actively recalling the answers the user presses the reveal answer button to test their accuracy B) The clozed stems are revealed and the user provides feedback to the software regarding if they actively recalled the correct answer and how easy it was for them (Re-do, Ease 1, and Ease 2).

members to access uploaded content, which is advantageous given membership may change with time. Examples of these services include those offered by Google, Dropbox, and Microsoft, among others. In addition to cost, it is recommended to look for a service that will allow for the storage of large quantities of data, as many cards may contain images. With regards to ease of use, consider how the cloud storage service permits users to create, move, and change files and folders. Furthermore, cloud services that are flexible in allowing designation of varying permission types (e.g. owner, can edit, can view, etc.) are preferable since member roles may change as the project develops. With the potential that many members may be contributing and editing shared material, it is also important to choose a cloud storage service that has a revision history. This allows for transparency among the group and ideally permits recovery of previous versions, should files be accidentally overwritten or deleted. Lastly, cloud storage services which notify users when new content is available will allow rapid access to recently completed flashcard decks.

Tip 10

Maintain the collaboration

Success of a collaborative flashcard project depends on the continuing commitment of its members. Ultimately, members who find the digital flashcards to be a valuable tool will continue with the project; whereas, those who do not use them may decide to withdraw. Fostering a safe, non-judgmental environment will allow members to engage in constructive discussion and avoid conflict.

Maintaining a successful flashcard project also involves recruiting new members to the project as it evolves. This process can be facilitated by creating a mentorship program. Mentors take on the responsibility of providing a run-through of the project's structure and function, and demonstrating how to create, review, and study digital flashcards. It could also be beneficial for the mentor to edit the first flashcard deck created by a new member to make sure that it meets the expected standards (*see Tip 7 and Tip 8*). This strategy would facilitate the integration and engagement of new members to the project.

Tip 11

Manage project operations

As is the case with any collaboration among peers, team management is critical for efficient operation. When first establishing the flashcard project, regular meetings should be held to allow for discussion around troubleshooting and project evolution. Three important principles facilitate achievement of project operation goals: regular monitoring of performance using the spreadsheet (*see Tip 4*), providing members with constructive feedback regarding performance, and consideration of member suggestions for project improvement. The project lead should communicate updates with students and involved faculty.

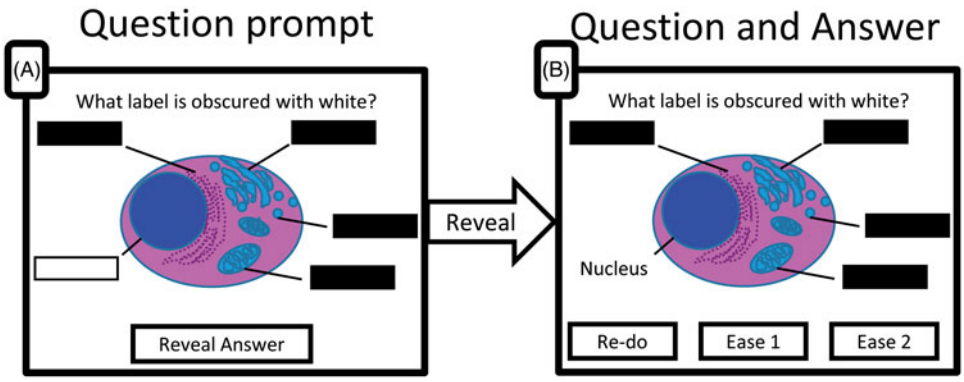

Figure 3. Example of an image occlusion flashcard testing the organelles in a cell. A) After actively recalling the answer the user presses the reveal answer button to test their accuracy B) The obscured information is revealed and the user provides feedback to the software regarding if they actively recalled the correct answer and how easy it was for them (Re-do, Ease 1, and Ease 2).

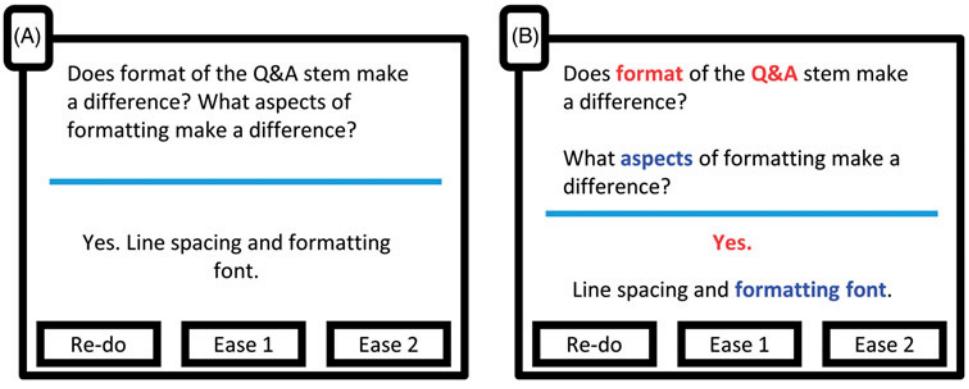

Figure 4. Formatting flashcard content improves clarity. A) Flashcard without line spacing and font formatting. B) The same flashcard with formatting that improves clarity and reduces cognitive strain.

Tip 12

The flashcard project as a lifelong study tool

Lifelong learning is a fundamental component of practicing medicine. While the majority of digital flashcards may be created during the pre-clerkship years when most of the didactic curricular material is encountered, they may end up serving as a lifelong study tool to maintain long-term retention. To accomplish this, we recommend identifying flashcards with high-yield clinical content and subsequently studying them after pre-clerkship.

For members of a digital flashcard project who desire to continue making flashcards during clerkship, we recommend that they plan assignments based on the distribution of the team across the various rotations. Completed decks would be shared and available for all members when they get to the corresponding rotations. These decks may also be used in residency for review of relevant content.

Finalized digital flashcards may be passed on to the incoming class. The twelve tips outlined in this article remain applicable to an incoming class and may be helpful for them to improve existing decks and capture advances in medical knowledge.

Conclusions

Medical students can benefit from studying with evidence-based technologies that improve factual and clinical knowledge retention. Digital flashcards are an example of such a study tool that may be used during and beyond undergraduate medical education. Digital flashcards combine the principles of active recall and spaced-repetition into an interactive self-directed study tool that will evolve with learners' stage of medical career, changing clinical guidelines, and emerging scientific knowledge.

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Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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