

# Promoting Interleaved and Spaced Practice in Anatomy and Physiology Students

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## Abstract

Students' academic performance in college can be impacted by varying background experiences and skill levels. This article describes a lesson designed for undergraduate Anatomy and Physiology students to address the challenge instructors face of disparate study skills among their students. The scaffolded activity aims to provide evidence-based study strategies, including flash cards, spaced practice, and interleaved practice. In-class activities and periodic homework assignments guide students in creating and using flash cards effectively. The goal is to reduce the academic performance gap between well-prepared and underprepared students. Data from the lesson plan demonstrates its potential to narrow gaps in performance on summative assessments. The article highlights the novel aspects of the lesson plan and discusses the implications of the findings. Limitations are also addressed to provide a comprehensive perspective on the study's outcomes. In addition, the adaptable nature of the lesson plan makes it suitable for modification and implementation in other courses and educational contexts.

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## Learning Goals

Students will:

- ◇ understand the value of flash cards, interleaved practice, and spacing in learning anatomy and physiology.
- ◇ understand a variety of anatomical terms commonly used in the medical field.

## Learning Objectives

Students will be able to:

- ◇ utilize the study methods of flash cards, interleaved practice, and spacing to improve exam performance in anatomy and physiology.
- ◇ define the common prefixes and suffixes used in anatomy and physiology.
- ◇ accurately use anatomical terms to describe the human body and its physiological processes.

## INTRODUCTION

The ability to accurately and efficiently recall information learned in science courses is critical to student success in their future courses, careers, and everyday life. Students pursuing careers in the medical field are acutely aware of how important foundational knowledge is to their success in future medical courses and careers (1). Unfortunately, some of the most common study strategies students use to acquire declarative recall and prepare for summative assessment, such as massed practice—completing the bulk of designated study time in close proximity to the assessment (also known as “cramming”)—are ill-suited to promote long-term retention of information (2). In addition, even when students know that massed practice yields lower long-term retention of information, students are still more likely to use this strategy (3). This lesson plan is intended to help students overcome the tendency to rely on study strategies that yield poor outcomes and build proper studies strategies with evidence-based practices.

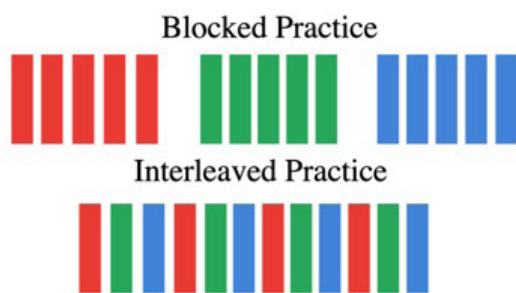
Anatomy and Physiology courses are an ideal learning environment to implement activities that promote content recall because of the large amount of content knowledge needed in this field. Students must first gain a baseline understanding of common terminology and structures that can then be applied to higher-order cognitive skills. Unlike subjects such as mathematics, where concepts are often abstract and sequential, anatomy and physiology courses demand the memorization and understanding of vast arrays of detailed, interconnected biological systems and structures. This content density presents a significant hurdle for students, as it requires not only the retention of a large amount of factual information but also the ability to integrate these facts into a coherent understanding of human biology. Studies have shown that the sheer volume of information in anatomy and physiology courses can overwhelm students, leading to ineffective study strategies and ultimately impacting academic performance negatively (4). However, relatively simple interventions have shown promise

in introducing students to effective study strategies that can increase summative exam performance (5). In addition, success in anatomy and physiology courses is correlated with success in later programs and future state licensures (6, 7), emphasizing the importance of building effective learning strategies for success in this course.

In the context of anatomy and physiology education, it is important to acknowledge the distinction between high- and low-structure courses. High-structure courses, as explored by Beck and Roosa (8), emphasize frequent and diverse assessments, and active learning strategies, which contrasts with the traditional lecture and infrequent testing format of low-structure courses. This contrast is critical in anatomy and physiology, where the substantial volume and complexity of the content necessitate continuous student engagement and adaptive learning methods.

Cognitive sciences and learning theory have developed many techniques that can be used in high-structure courses and have shown effectiveness in promoting long-term retention of information compared to massed practice. Among these techniques is spaced practice, sometimes referred to as distributed practice, a study strategy that involves spreading out studying over time prior to the assessment. A student who used massed practice for an assessment might spend two hours studying for an assessment the night before an exam, whereas a student who spaced their practice may spend the same two hours studying but spread that time out over two weeks prior to the exam in 30-minute increments. Temporal spacing during study tends to produce greater recall and long-term retention of a variety of different concepts compared to massed practice (9–13).

Another effective study strategy to promote long-term retention of information is interleaved practice, or the practice of varying the order of concepts during a study session. This is contrasted with blocked practice, which is the method of studying all of one topic together before moving on to another topic. For example, when studying for an assessment that includes concepts A, B, C, and D, a student wishing to interleave 12 units of study may perform them in the following order: A, B, C, D, A, B, C, D, A, B, C, D, whereas blocked practice might entail the student studying A, A, A, B, B, B, C, C, C, D, D, D (Figure 1). The study strategy of interleaved practice has been shown to increase retention and performance on exams (14).



**Figure 1.** Diagram depicting the difference between blocked and interleaved practice. Colors indicate topics of study. Blocked practice groups topics of study together, while interleaved practice changes the topic of study frequently.

Many studies that support interleaving and spaced practice are performed in a laboratory setting with highly controlled environments (12, 15, 16). In addition, studies commonly use relatively short time frames for measuring retention of information (minutes, hours, and days) (17). This lesson plan describes and provides data demonstrating the effectiveness of interleaving and spaced practice in a long-term experiment (one semester with a cumulative final exam). In addition, the data collected was from a classroom setting, which may allow for better replication of the benefits compared to laboratory settings. Finally, it is clear from the literature that spaced and interleaved practice are superior to massed practice, however, students still tended to rely on massed practice (3). To complicate the problem, despite substantial learning gains, students have reported learning less from interleaved practice (18), a perception that may be due to increased cognitive demand when interleaving. This lesson describes a methodology using visual cues on note cards (VC Flash Cards) that could increase student buy-in and can help promote interleaved and spaced practice in various courses, including Anatomy and Physiology. VC Flash Cards have designated markers that help students interleave and space their studying by keeping track of terms and concepts students are recalling correctly and incorrectly.

### Intended Audience

This lesson is designed for undergraduate Anatomy and Physiology students. Students were mostly in their first and second year at a small private liberal arts university, most of whom were pre-nursing (~70%), pre-med (~15%), or biology majors (~15%). Prerequisites for this course included General Biology I and the accompanying lab. Students in this course were required to take the accompanying Anatomy and Physiology lab concurrently. However, with minor modifications this lesson could be adapted for a variety of undergraduate science courses, given that the focus is to promote interleaved and spaced practice. Other high volume content courses that may benefit from this lesson plan include biochemistry, microbiology, pharmacology, or molecular biology. The content is tailored to meet the needs of individuals seeking to optimize their learning strategies and improve their understanding of complex anatomical and physiological concepts.

### Required Learning Time

This lesson described in this paper took place over one 16-week semester. The majority of the activities took place in the first unit of the semester, lasting approximately four weeks. Modifications that will allow for shorter interventions are described in the discussion section.

### Prerequisite Student Knowledge

The content covered in this lesson includes anatomical terms and directions, basic chemistry terms, cell organelles, and terms relating to tissues. It is not necessary for students to have prior knowledge of these topics. The main goal of the lesson is to provide students with evidence-based study strategies. Some students may already use these techniques (or variations), however implementing this lesson early on in the semester allows students lacking proper study skills to catch up to their peers.

## Prerequisite Teacher Knowledge

Having knowledge of anatomical terms and directions, basic chemistry terms, cell organelles, and terms relating to tissues will help instructors seeking to implement this lesson as is. In addition, understanding the benefits of the study strategies being utilized (interleaved and spaced practice) will help instructors answer student questions and increase student buy-in.

## SCIENTIFIC TEACHING THEMES

### Active Learning

This lesson plan promotes active learning by engaging students in the creation and use of flash cards as a study strategy. By actively constructing their own flash cards and employing spaced and interleaved practice, students take an active role in their learning process and begin to develop autonomy in facilitating their own learning, a process that has demonstrated benefits to students (19). This approach can establish declarative understanding of the course material, enhances long-term information retention, and begins to develop self-regulated learning practices (20, 21).

The use of flash cards facilitates active recall and self-assessment, as students regularly evaluate their knowledge and track their progress. The incorporation of daily and weekly benchmarks encourages repeated retrieval practice, reinforcing memory consolidation and promoting long-term retention (20). Furthermore, the interactive nature of flash card usage allows students to actively participate in the classroom by asking questions and seeking clarification when necessary.

### Assessment

Assessment in this lesson plan is multifaceted, serving both formative and summative purposes (22). The lesson plan includes formative assessments through homework assignments, providing scaffolding and feedback to ensure students stay on track with flash card creation and usage. The summative assessment aligns with the learning objectives and activities of the course, evaluating students' comprehension and mastery of the unit's content. Multiple-choice recall questions, including those related to the flash card term lists, enable instructors to measure students' achievement and gauge the effectiveness of the study strategies. By incorporating assessment items that align with homework and activities, the summative assessment can provide a comprehensive evaluation of student learning (23).

### Inclusive Teaching

This lesson plan embraces inclusive teaching practices by providing various options for students to engage with the flash card activity. Instructors accommodate diverse student needs by offering the choice between submitting physical flash cards or digital images, allowing students to select the format that suits them best. The assignment submission options, either physical or digital images of flash cards, offer flexibility and accommodate students with different access to technology (24). The supporting materials, such as the QR code with a detailed explanation, cater to a range of academic preparedness by providing additional support as needed.

The flash card strategy itself promotes inclusive learning by fostering active participation, self-regulated learning, and metacognitive awareness. Students of all backgrounds can benefit from spaced and interleaved practice, regardless of their prior knowledge or learning preferences (25). The lesson encourages instructors to create an inclusive classroom environment by inviting questions, addressing inquiries, and providing corrective feedback to enhance student understanding and success.

Furthermore, the lesson plan acknowledges common challenges that students may face and offers strategies for overcoming them. By promoting the benefits of spaced practice, instructors help students understand the value of this study strategy and its positive impact on long-term retention. Instructors should acknowledge that students may have established alternative study strategies and may have schedules that make following this lesson plan difficult. Instructors should do their best to emphasize the evidence-based effectiveness of this flash card approach, but respect students' autonomy. In this way, instructors can promote inclusivity and encourage students to find what works best for them within the context of the course.

Most importantly, data from implementation of this lesson plan has demonstrated an ability to reduce performance gaps in summative assessment performance between underprepared students and their peers (data can be found in the discussion section). This lesson plan provides an inclusive environment for students that may not have had the opportunity to build proper study strategies in their primary and secondary schooling.

## LESSON PLAN

### Preparation and First Class Session

This lesson requires students to create flash cards with specific features to promote interleaved and spaced practice. The flash cards used in this lesson, VC Flash Cards, can be found in the supporting materials and in Figure 2. The flash cards can be printed out and given to students along with a brief explanation of how the cards should be used and the subsequent assignments related to this lesson. The lesson plan in table format can be found in Table 1.

Prior to the implementation of the lesson, the instructor should devote approximately one hour to material preparations. It may be helpful to print and cut out the VC Flash Cards, ensuring that each student would have a packet with the appropriate number of cards and dividers. Alternatively, for large enrollment courses, the instructor may opt to provide online templates of the cards (Supporting File S1) and require students to print and prepare their own VC Flash Cards. To further support the students' learning, the instructor should create lists of specific terms that they should be using the VC Flash Cards on, especially for the first round of VC Flash Card creation. Underprepared students often lack the ability to appropriately select important terms they should study. By creating a list of terms for the students (or scaffolding the skills necessary to determine the important terms) instructors can help students prepare for future summative

**Daily**

**Instructions**

Instructions

- Try to study your card daily (a few minutes per day)
- On an incorrect recall, put the card at the back of your **daily** pile
- On a correct recall, make the appropriate box in the upper right corner on the answer side
- After 3 correct recalls on a single card, move that card to the **weekly** pile
- After 3 correct recalls on cards in the **weekly** pile, move that card to the **once before exam** pile
- Only study cards in the **daily** pile. Shuffle cards frequently
- At the end of the week, shuffle the cards from the **weekly** pile back into your daily pile
- A few days before the exam, shuffle all the cards together and try to get at least one correct recall of all your cards

**Weekly**

**Once Before Exam**

**Front: Term**

\_\_\_\_\_

**Back: Definition/Explanation**

Daily ☐ ☐ ☐

End of week ☐ ☐ ☐

Before Exam ☐

Figure 2. Visual cue flash cards.

assessments. The VC Flash Cards are particularly useful for recall and declarative knowledge learning objectives; however, the overall activity could be modified for higher-level objectives. For example, instructors could ask students to not only create VC Flash Cards for specific terms, but include learning objectives, case studies, or open-ended questions that could benefit from interleaving and spaced practice.

Prior to the first class session, the instructor should familiarize themselves with information on interleaved and spaced practice. Finally, the instructor should review slides in Supporting File S2. that will be used to deliver this content. The instructor should make necessary modifications to the slides to them specific to their course.

### First Class Session

Proceed with the first class session with the regular content delivery of the course, consisting, for example, of lectures and activities. Then use the prepared PowerPoint slides to guide the content delivery of the study strategies of spaced and interleaved practice.

After the content delivery, the instructor should dedicate ten minutes to instructing the students on the VC Flash Card usage. Using the prepared slides, explain how the VC Flash Cards are designed to promote interleaved and spaced practice which can improve recall and declarative knowledge (note to students that other study strategies can and should be used for higher-order learning objectives). Explain to students that they will be required to make VC Flash Cards for the important terms covered in the first unit. Each week students will submit

their cards (either physical or images of their cards) to ensure they are spacing their studying. Along with making the cards, students should use the cards daily. Students will use the cards as follows. All cards will start in the “daily” pile and each day students will test their recall of all the cards they have created. When they perform an accurate recall, they will check the box in the upper corner of the card to not the successful recall. After three successful recalls of a single card, students will move that card from the “daily” pile into the “weekly” pile. Students will continue to review the remaining cards in the “daily” pile with the goal of moving all cards into the “weekly” pile by the end of the week. On an incorrect recall, students will put the card back into the daily pile without checking any box. Students should frequently shuffle their “daily” card pile. At the end of the week, all cards from the “weekly” pile will be moved back to the “daily” pile, and students will repeat this process. New cards will be added to the “daily” pile as the course progresses. When a card gets three checks in the “daily” and “weekly” category, this card is moved to the “before exam” pile. These cards will be shuffled back into the “daily” pile just prior to the summative assessment and the goal for students is one accurate recall of their cards before the exam. The goal for students is to have as few cards in their “daily” pile as possible. Some students will be able to move cards out of their pile with little effort, other students will need several attempts and may need several study sessions per week. During the explanation of this process, encourage student participation by inviting questions and providing answers to any inquiries regarding the VC Flash Cards. Remind students that there is a QR code with a detailed explanation of how to use the VC Flash Cards if they need a reminder. End the class with the first homework assignment.



To reinforce the learning experience and provide formative feedback, the instructor should assign Homework Assignment 1 to the students, which requires students to submit their VC Cards for assessment and feedback. This formative assessment will provide scaffolding to the students to stay on pace with making the cards and using them to study. Explain the expectations of the assignment and outline the acceptable ways in which students could submit their completed work. Consider the appropriate amount of time students need to create the VC Flash Cards on the term list.

The original lesson plan allowed for one week to complete the first assignment. Use the course learning management system to aid in deadline reminders and submission of Homework Assignment 1. Because this is a formative assessment, consider grading this assignment as credit/no credit, but if the instructor has the time and resources, they should check the VC cards for accuracy and misconceptions. Instructors can also note common errors or misconceptions and bring them up to the class in subsequent class periods. Students were allowed to either submit the physical VC Flash Cards for completion credit or submit images of their completed cards. Note that students were not allowed to create completely digital flash cards. This was a choice by the researchers to ensure students had visual cues to promote interleaving and spaced practice on the cards. In future units, when proper study strategies may be established, instructors could consider allowing students to complete their flash cards via a digital tool (e.g., Anki or Quizlet). However, this lesson plan asked students to create physical flash cards, and the results are specific to this mode of creation. Upon receiving the submissions, the instructor should dedicate the appropriate time needed to review the students' VC Flash Cards. Provide corrective feedback to students on their VC Cards such as noting incorrect or incomplete definitions, or positive reinforcement when students create exemplar cards.

### Subsequent Class Sessions

In the following class sessions, continue with the regular content delivery, employing various teaching methods as related to the course. It can be helpful to remind the students about the VC Flash Card assignment and emphasize the terms they should be adding to their VC cards. By doing so, instructors can reinforce the concepts covered and encourage active engagement with the flash cards and promote interleaved and spaced practice. Instructors can also include review questions pertaining to previously covered content. This will allow students to gauge if the study strategies are preparing them for the upcoming summative assessment.

Assign subsequent homework assignments throughout the unit. In the original lesson four-week lesson plan, there were two "check point" homework assignments. Modify the number of homework assignments based on the length of the unit, keeping in mind that these formative assessments will keep students on track making the cards and using them to study.

### Unit Assessment

To gauge the students' comprehension and mastery of the learning objectives for the unit, use the appropriate summative assessment. Be sure that the summative assessment aligns with learning objectives and activities of the course and consider adding specific assessment items that were covered in the homework assignments. In the original lesson plan several

multiple-choice recall questions were included over the VC Flash Card term lists. By incorporating relevant questions related to the VC Flash Cards, instructors can evaluate the students' progress and measure their achievement in the unit.

In subsequent units, instructors can consider using the above format on the new content, or if students were successful, consider removing some scaffolding and allowing students more autonomy. For example, the instructor could inform the students that there will not be formative homework assignments, but students who benefited from the format should try to maintain this routine. In addition, instructors could not provide students with term lists, but demonstrate how students could make their own term lists from their notes.

### Common Challenges

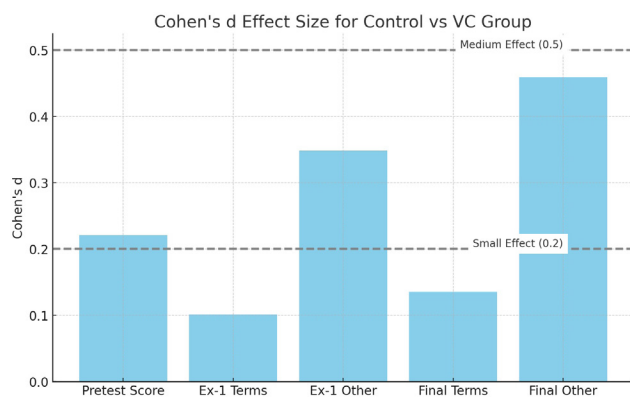
While implementing this lesson, several common challenges may occur. First, some students may not like the overall structure of this extended study sequence. Many students would prefer to mass their practice in close proximity to the summative assessment. It is helpful to remind students of the benefits of spaced practice, and highlight the long-term retention benefits, especially when learning content that will be useful in future courses and careers. On a similar note, students may comment that they don't have time to complete the necessary requirements each week. In this case, consider all the course expectations to evaluate whether this claim is accurate. If the requirements are necessary and within reason, explain to students that spaced practice can reduce the amount of study time needed to prepare for a summative assessment.

Students may also note that they have alternative study strategies and schedules that work for them. In this case, it may be helpful to inform students that the goal of this lesson sequence is to expose them to an effective, research-based, study strategy, however if they do not find it helpful, they can use other study strategies for the future units.

Finally, some students do not complete the lesson plan as designed. Occasionally students report that even after completing the homework assignments, they did not space their practice. Reminders throughout the unit, such as asking students if they are using the cards each day or asking what are the biggest hindrances preventing them from using the cards, can help students stay on task. Even with scaffolds in place, some students will not complete the lesson as designed.

### TEACHING DISCUSSION

The goal of this lesson was to provide an evidence-based study plan to students studying Anatomy and Physiology. In particular, this lesson aimed to help students that may be entering post-secondary education lacking proper study skills build those skills and bridge the opportunity gap with their peers. In order to measure the effectiveness of this lesson in allowing students to build study skills and reduce performance gaps in summative assessment performance, we implemented a quasi-experimental design and collected data at several points throughout the unit and semester. In two sections of Anatomy and Physiology taught by the same instructor using the same instructional materials, we collected pre-test data to obtain a rough measure of the students' prior knowledge and course success predictors. Next, in one randomly assigned



**Figure 3.** Bar graph depicting the effect sizes, calculated using Cohen's  $d$ , comparing the control group (standard flash cards) and the experimental group (visual cue flash cards). Notably, students in the control group outperformed the experimental group in all variables where study strategies were not provided to students, however, when provided with the VC cards, the performance gap disappears almost entirely. The dotted lines represent thresholds for small (0.2) and medium (0.5) effect sizes.

section (experimental section,  $n = 36$ ), we implemented the lesson plan as previously described. In the other section (control section,  $n = 46$ ), we gave students the same lesson plan, activities, and assignments, but had them use standard flash cards without visual cues on the cards. Our goal was to measure the effectiveness of the lesson plan alongside flash cards that gave students visual cues to remind and prompt them to interleave and space their practice, compared to standard flash cards. We then collected survey data on student usage and thoughts on the VC Flash Cards, as well as summative exam data (unit exam and final exam). This research was reviewed and approved by the IRB and deemed exempt from future IRB approval. All statistics were performed using Excel and Minitab 20.

### Evidence of Effectiveness

Several comparisons were made between data from the control group (standard flash cards) and the experimental group (VC Flash Cards) and is summarized in Figure 3. The effectiveness was quantitatively assessed using Cohen's  $d$  analysis to measure the effect sizes between the control and VC groups. Analysis from the pre-test data found that students in the control group outperformed students in the experimental group. This trend was also found in comparison of the exam 1 questions that did not directly relate to the flash card content (Ex-1 Other). This led us to believe that students in the control group had higher prior knowledge of anatomy and physiology and outperformed students in the experimental group when no study strategies were explicitly assigned. However, when comparing the questions on exam 1 that pertained to content covered by the flash card assignments (Ex-1 Terms), we see this difference almost disappears. The same trend was found on the subsequent final exam (Final Terms and Final Other), nearly three months later.

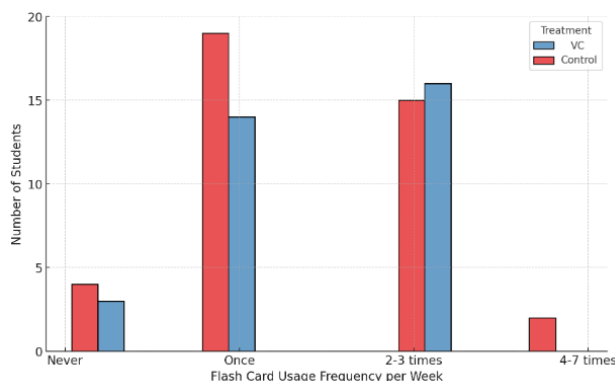
The results described above led us believe that the use of VC Flash Cards that remind and prompt students to interleave and space their practice may help reduce performance gaps between students that are well-prepared for post-secondary courses and those that lack the proper study strategies to succeed in highly demanding courses. Many students do not

get the opportunity to build study strategies in their primary and secondary education for a variety of reasons, including lack of guidance from instructors and mentors, lack of challenging course materials, or simply a lack of exposure to proper study strategies. By implementing this lesson plan, instructors may be able to help students build the evidence-based study strategies of interleaved and spaced practice.

### Student Observations

Students were surveyed throughout the unit to obtain qualitative data on their thoughts and opinions of the lesson. Overall students tended to appreciate the lesson described in this article, especially students who lacked proper study skills prior to this course. For example, one student noted *"I have never studied like this before, but I'm going to use these flash cards in my other classes."* Another student noted *"I liked making the cards, it helped me spread my studying out."* However, we also found some students saying that this type of assignment was overly constricting. For example, one student noted *"I like to study in my own way, so these cards were not useful to me."*

Data on self-reported use of flash cards for the control and experimental group can be found in Figure 4. One of the more striking observations we found was related to the students' daily use of flash cards. Homework assignments were spaced out throughout the unit to keep students on track with making the flash cards. However, many students reported only using the cards one-to-three times per week, which was much lower than the expectations the instructors gave to students. This may be due to students having a busy schedule and not being able to dedicate additional time to one course, or students may have misunderstood the proper procedure and only made the flash cards each week and didn't use them after that. One student noted in their survey *"This style of studying is brilliant, but I just don't have the time to study this way."* This sentiment is consistent with previous research on interleaved and spaced practice indicating that some students are aware that massed practice (cramming) is not an effective study strategy but choose to implement this style anyway (3). While it is tempting to continue to add more assignments and checkpoints to this lesson plan, it is important to leave some degree of autonomy to students. Some students may be aware of proper study strategies and choose not to use them, however this lesson plan is designed to provide students who are under-prepared



**Figure 4.** Student self-reported usage of flash cards per week. Almost all students did not use the daily, as intended, however, many students used the cards between 1–3 times per week.

for rigorous post-secondary courses with evidenced-based study strategies in order to bring them up to speed with their college ready peers.

### **Suggested Improvements**

One improvement to this lesson would be to include assignments that required students to use the cards. As stated above, it appears that some students may have thought the creation of the flash cards was all that was necessary for the assignments. And to the students' credit, they only received course credit for making and submitted the cards. Instructors could consider giving students points for using the cards daily throughout the week. We opted not to require daily usage but recommend it, due to the high level of involvement already expected throughout the unit.

Some students noted that they would have preferred an online adaptation of the lesson. We chose to require all students to make physical flash cards in order to evaluate the effectiveness of visual cues on the flash cards. If instructors are less concerned with measuring the effectiveness of the lesson, they could consider allowing students to use software to aid the creation of the flash cards, keeping in mind that cues on the cards appear to help students use them properly. We suggest using the software Anki, which promotes interleaved and spaced practice by shuffling cards, and deprioritizing cards that have consistently been accurately recalled.

### **SUPPORTING MATERIALS**

- S1. AandP Study Strategies – Template for VC Cards
- S2. AandP Study Strategies – PowerPoint slides describing interleaving and spaced practice

### **ACKNOWLEDGMENTS**

We would like to thank the students that participated in the study and provided consent for their data to be used in this article. Thank you to IRB for reviewing and approving this study. We would also like to thank our institution for allowing us to perform this study in pursuit of furthering our knowledge of science education. Finally, we would like to thank those who gave us feedback, including the peer reviewers and editors.

**Table 1.** Lesson plan timeline. This table summarizes the preparation and implementation of activities, assignments and assessments related to VC Flash Cards.

Activity	Description	Estimated Time	Notes
<b>Preparation for Class</b>			
Material Preparations	<ol style="list-style-type: none"> <li>1. Print out and cut VC Flash Cards</li> <li>2. Create packets of the appropriate number of cards and dividers for each student</li> <li>3. (Optional) Make lists of specific terms students should be using the VC Flash Cards on</li> </ol>	1 hour	With large classes, consider having students print and cut out their own cards. VC Flash Cards Template can be in Supporting File S1.
Review	<ol style="list-style-type: none"> <li>1. Review the slides on interleaved and spaced practice</li> </ol>	5 min	
<b>Class Session 1</b>			
Content Delivery	<ol style="list-style-type: none"> <li>1. Use the normal content delivery of the course (lecture/activities)</li> </ol>	Variable	
VC Flash Card Instructions	<ol style="list-style-type: none"> <li>1. Use the prepared slides to explain to students the procedure and benefits of interleaved and spaced practice</li> <li>2. Ask for and answer questions students have regarding the VC Flash Cards</li> </ol>	10 min	Prepared PowerPoint slides can be found in Supporting File S2.
Assignment	<ol style="list-style-type: none"> <li>1. Assign students Homework Assignment 1</li> <li>2. Explain the expectations of the assignment and the acceptable ways students can submit the assignment</li> </ol>		
<b>Subsequent Class Sessions</b>			
Content Delivery	<ol style="list-style-type: none"> <li>1. Use the normal content delivery of the course (lecture/activities)</li> <li>2. Remind students of the VC Flash Card assignment and highlight the terms they should be adding to their VC cards</li> </ol>	Variable	
<b>Homework Assignment 1</b>			
Submission	<ol style="list-style-type: none"> <li>1. Either have students submit the physical VC Flash Card for completion credit or allow students to submit images of their completed cards</li> </ol>		
Feedback	<ol style="list-style-type: none"> <li>1. Review student VC Flash Cards and provide any feedback that would benefit student performance</li> </ol>	~1 hour	
<b>Subsequent Class Sessions</b>			
Additional VC Cards	<ol style="list-style-type: none"> <li>1. Continue to deliver content in the unit</li> <li>2. Assign more VC Flash Cards as necessary</li> <li>3. Use additional homework assignments to model proper spaced studying</li> <li>4. Encourage students to use the VC Flash Cards properly periodically throughout the unit (frequent study sessions and interleaving concepts)</li> </ol>		
<b>Unit Assessment</b>			
Assessment	<ol style="list-style-type: none"> <li>1. Include assessment items on the subsequent summative assessment related to concepts covered with VC Flash Cards. (Be sure to match the assessment to the learning objectives of the course/ unit)</li> </ol>	~1 hour	



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