SpacedEd is a platform designed to allow learners and teachers to harness the educational benefits of spaced education. Spaced education is a novel method of online education developed and rigorously investigated by Dr. B. Price Kerfoot (Associate Professor, Harvard Medical School).

It is based upon two core psychology research findings: the spacing effect and the testing effect. In more than 10 randomized trials completed to date, spaced education has been found to:

- Improve knowledge acquisition,
- Increase long-term knowledge retention (out to 2 years),
- Change behavior,
- Boost learners' abilities to accurately self-assess their knowledge.

In addition, spaced education is extremely well-accepted by learners.

The spacing effect refers to the psychology research finding that information which is presented and repeated over spaced intervals is learned and retained more effectively, in comparison to traditional bolus ('binge-and-purge') methods of education.

The testing effect refers to the research finding that the long-term retention of information is significantly improved by testing learners on this information. Testing is not merely a means to measure a learner's level of knowledge, but rather causes knowledge to be stored more effectively in long-term memory.

The spaced education methodology is content-neutral and thus can be utilized to learn most anything. Potential applications range from teaching chemistry concepts to high school students to reinforcing Arabic language skills among health workers in the Middle East. It can also be used to reinforce educational material which was initially presented in the classroom. The full multi-media capabilities of the Internet can be harnessed to create a rich and effective learning experience.

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**Spacing Effect**

The "spacing effect" refers to the psychology research finding that information which is presented and repeated over spaced intervals is learned and retained more effectively, in comparison to traditional bolus ("binge-and-purge") methods of education.
Since its discovery in the late 19th century by the German psychologist Hermann Ebbinghaus, the spacing effect has been extensively studied. Even though this research has repeatedly demonstrated the spacing effect’s potent ability to improve learning retention, these findings have only had limited translation into formal educational practice. Recently, the spacing effect was found to have a distinct neurophysiological basis: Sisti et al (2007) showed that spaced learning in rats improved neuronal longevity in the hippocampus (a region of the brain which is important for long-term memory).

Selected References on the Spacing Effect


Testing Effect

The "testing effect" refers to the research finding that the long-term retention of information is significantly improved by testing learners on this information. Testing is not merely a means to measure a learner’s level of knowledge, but rather causes knowledge to be stored more effectively in long-term memory.

Some elegant research was recently reported by Dr. Karpicke, Dr. Roediger and their colleagues demonstrating the profound improvement that testing (retrieval practice) can generate on longer-term retention of knowledge. Further evidence suggests that testing with fill-in-the-blank questions (free recall) produces greater improvements in retention, compared to testing with multiple-choice questions (cued recall).

Selected References on the Testing Effect


Proven to Work

Our method has been proven to work. Data from over 10 large randomized controlled trials (RCTs) demonstrate that it is effective, efficient, addictive and changes behavior. Some key highlights are:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Claim</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective</td>
<td>Generates improved long-term retention of knowledge in only minutes a day.</td>
<td>• Increased retention of knowledge for 2+ years (compared to self-study) in RCT of 524 physicians.</td>
</tr>
<tr>
<td>Changes Behavior</td>
<td>Proven to positively impact on-the-job performance and change even engrained behavior.</td>
<td>• Decreased unnecessary cancer screenings by 26% in RCT of 95 VA primary care providers, representing a potential cost savings of $650,000 per annum in test costs alone.</td>
</tr>
<tr>
<td>Efficient</td>
<td>Adaptive algorithm reduces time to acquire same amount of knowledge as non-adaptive methods</td>
<td>• 38% increase in learning efficiency due to adaptive algorithm (compared to non-adaptive method) in RCT of 93 medical students.</td>
</tr>
<tr>
<td>Addictive</td>
<td>Learning pushed on a daily basis requiring no more than 5 minutes a day and delivering instant feedback on progress is proven to be addictive.</td>
<td>• 77-95% of the 3500+ users to date request to enroll in more courses. • Completion rates greater than 70% • Preferred 3:1 over web-based teaching modules (a gold-standard of e-learning) in RCT of 724 physicians.</td>
</tr>
</tbody>
</table>

Example

Spaced education combines the educational benefits of both the spacing and testing effects. Course material is delivered electronically to learners at regular intervals in a test-question format. Upon submitting answers to questions, learners receive immediate feedback and educational material on that topic. The course material is then reinforced over spaced intervals to take advantage of the spacing effect. The delivery intervals, the spacing intervals and the number of reinforcements can be personalized to meet the specific needs of the learners.

SpacedEd courses use an adaptive reinforcement algorithm to customize the spacing and content of the course material for each learner based on his or her demonstrated knowledge level. By reducing unnecessary reinforcement of already-mastered content among learners with high baseline knowledge levels, SpacedEd's adaptive reinforcement has been shown to improve learning efficiency by 38%.

Here is an example how a SpacedEd course is structured:

- Each learner receives 2 questions every day via email.
• If a question is answered incorrectly, it will be repeated 1 week later.
• If a question is answered correctly, it will be repeated 3 weeks later.
• If a question is answered correctly two times in a row, the item is retired from the course and is no longer repeated.
• The learner completes the course when all of the questions are retired (answered correctly twice in a row).

Research

Spaced education is a novel method of online education based upon two core psychology research findings: the spacing effect and the testing effect. Spaced education was initially developed and then rigorously studied by Dr. B. Price Kerfoot (Associate Professor, Harvard Medical School) as a method to improve the long-term knowledge retention of medical trainees. In over 10 large randomized trials completed to date, spaced education has been found to:

• Improve knowledge acquisition,
• Increase long-term knowledge retention (out to 2 years),
• Change behavior, and
• Boost learners’ abilities to accurately self-assess their knowledge.

In addition, spaced education is extremely well-accepted by learners.

The spaced education methodology is content-neutral and thus can be utilized to learn most anything. Potential applications range from teaching geography to school children to documenting competence in accounting skills among small business owners. The full multimedia capabilities of the Internet can be harnessed to create a rich and effective learning experience.

On-Going Research Studies

• Adaptive Spaced Education to Assess and Improve Knowledge of Clinical Practice Guidelines: a Randomized Trial.
  (trial involves 1470 physicians in 63 countries)
• Adaptive Spaced Education for Longitudinal Progress Testing of Medical Students.
  (trial involves 724 students at 3 US medical schools)
• Adaptive Spaced Education for Longitudinal Progress Testing of Urology Residents.
  (trial involves 932 urology residents from the US and Canada)

Completed Research Studies – data under analysis

• Interactive Spaced Education for Longitudinal Progress Testing of Medical Students: A Multi-Institutional Randomized Trial
  (a 34-week trial involving 1067 students at 4 US medical schools)
• Spaced Education Versus Web-based Modules for Teaching Histopathology Diagnostic Skills to Urology Residents: A Randomized Controlled Trial.  
(a 45-week trial involving 724 urology residents across the United States)

• Interactive Spaced Education to Improve Clinicians’ Screening for Prostate Cancer: A Randomized Controlled Trial
(a 36-week trial involving 95 clinicians in northeastern Veterans Affairs hospital system.)

**Published Research Studies (most recent listed first):**


Matzie KA, Kerfoot BP, Hafler JP, Breen EM. Spaced education improves the feedback that surgical residents give to medical students: a randomized trial. Amer J Surg 2009: 197(2), 252-257  

Kerfoot BP, Armstrong EG, O’Sullivan PN. J Gen Intern Med. 2008; 23(7):973-8. [Interactive spaced education to teach the physical examination: a randomized controlled trial  


Kerfoot BP. Interactive spaced education versus web-based modules for teaching urology to medical students: a randomized controlled trial. J Urol 2008; 179, 2351-2357.  


Frequently Asked Questions

[Students]

This is the list of general Frequently Asked Questions. There is also an authoring FAQ [http://www.spaceded.com/info/faq_authors] available.

What is spaced education?

Spaced education is a new method of online education delivered by SpacedEd that has been shown in randomized trials to improve learning and boost knowledge retention. Spaced education combines two core psychology research findings: the spacing effect and the testing effect. Learners ranging from students to professionals find spaced education to be quick, effective, enjoyable, and addictive. SpacedEd courses are constructed as a series of questions and answers which are delivered to you on a regular schedule. As you answer the questions and learn from the answers, the spacing and content of future questions are adapted to your knowledge level. Over time, the course material is reinforced until you master and remember it.

What is the "spacing effect"?

The "spacing effect" refers to the psychology research finding that information which is presented and repeated over spaced intervals is learned and retained more effectively, in comparison to traditional bolus ("binge-and-purge") methods of education. SpacedEd harnesses the spacing effect by presenting and reinforcing course content over spaced intervals of time.

What is the "testing effect"?

The "testing effect" refers to the research finding that the long-term retention of information is significantly improved by testing learners on this information. SpacedEd harnesses the testing effect by utilizing a question-answer format for all course content. Asking thought-provoking questions worked for Socrates, and it is extremely effective within SpacedEd.

Will answering a few questions each day really teach me anything?

Definitely Yes! Multiple randomized trials conducted at Harvard Medical School have proven the efficacy of this approach. In the coming months we will make the published research findings available on the Research section of the SpacedEd web site.

What is "fixed spacing"?

Fixed spacing refers to SpacedEd courses in which the questions are presented and reinforced in a fixed pattern of spacing. Whether you answer a question correctly or not, the spacing and reinforcement of the material does not change.

What is "adaptive spacing"?

Adaptive spacing refers to SpacedEd courses in which the questions are presented and reinforced in a pattern which is customized to the knowledge level of the learner. The spacing
and reinforcement of the material adapts based on whether you answer a question correctly or not. Here is an example:

- You enroll in a 40-question course on how to grow the perfect tomato.
- You receive and answer 2 SpacedEd questions each day
- If you answer a question incorrectly, it is repeated in 7 days.
- If you answer a question correctly, it is repeated in 21 days.
- If you answer a question correctly twice-in-a-row, it is retired and is no longer repeated.
- You complete the course once all 40 questions are retired.

Do learners really like the reinforcement of course content?

Yes! Learners ranging from students to physicians see the repetition of questions to be a valuable opportunity to solidify their knowledge and to demonstrate that they have learned the material. They do not view the reinforcement of course content as a burden.

I do not want certain questions to be repeated. What should I do?

Please click on the "Do not repeat this question" button on the answer page for a question. That question will be retired and you will not see it again.

What does it mean to retire a question?

A question is "retired" if it will no longer be repeated in the course. In a "fixed spacing" course, this occurs after the final scheduled repetition of a question. In an "adaptive spacing" course, this occurs when you meet the retirement criterion in the course settings (e.g. answering a question correctly twice-in-a-row).

Why do questions expire in adaptive courses?

In SpacedEd courses which use "adaptive spacing", the learner must answer a question within the timeframe of the shortest spacing interval. The SpacedEd system is set-up in this manner to ensure proper spacing intervals are maintained even if a learner falls behind in a course. Consider the following example: You are in a course in which a question is repeated in 7 days if it is answered incorrectly and in 21 days if answered correctly. If you do not answer a question within 7 days of it being sent to you, it will be marked as incorrect and will be re-sent to you.

How long does it take to complete a SpacedEd course?

This depends on the settings you select for a course. While the courses usually take only a few minutes each day, they can take several weeks or more to complete. For fixed-spacing courses, the completion dates can be calculated with certainty. For adaptive-spacing courses, the duration required to complete a course depends on how well you are doing in a course.

In an adaptive-spacing course, are questions repeated based on the date I answer it or the date on which it was sent to me?
Questions are repeated based on the date it was sent to you. The SpacedEd system was designed in this manner to reduce the clustering of course questions.

What are the green bars on the dashboard?

The green bars represent your progress in a course. The top bar represents the percentage of course questions that you have answered at least once. The bottom bar represents the percentage of questions that you have retired.

Why are there gaps in the scheduling of questions?

In adaptive-spacing courses, gaps may appear in the delivery of questions once you have answered all of the questions at least once. This is expected. You can see when future questions will be delivered by clicking on the name of any course you are taking on your Dashboard and then selecting the Course Schedule tab.

Why do I have to wait a day or more until I can answer the next question?

Learning small amounts of material over multiple sessions ("distributed practice") can significantly improve knowledge retention compared to "bolus" learning of large amounts at a single time point. (Unfortunately, the bolus "binge-and-purge" approach is extremely common in education.)

Which is better, fixed spacing or adaptive spacing?

The answer depends on the course material and how you like to learn. A fixed spacing course is a defined length of time, and the course material is reviewed a consistent number of times. The duration of an adaptive spacing course depends on whether you answer the questions correctly or not. One Harvard randomized trial showed the adaptive algorithm increased learning efficiency by more than 35%.

What is the optimal number of questions to receive each day?

The randomized trials suggest that a nice balance is 2-3 questions per day. This number allows you to cover all the course material in a reasonable amount of time, but still allows you to complete your course material in just a few minutes each day. While the course author will assign some suggested defaults settings for the course, the ultimate decision is up to you.

What are the optimal spacing intervals for the questions?

The spacing intervals should be selected based on when you want to optimize retention of your learning. In the Harvard research trials, the spacing intervals have varied from 5 days to 6 weeks. Ideally, the spacing interval should be about 4-10% of the retention interval. In other words, if you want to optimize your retention of learning one year (50 weeks) later, the spacing interval should be between 2-5 weeks long.

How frequently should I receive the questions?
We suggest receiving 2-3 questions every 1-2 days. These settings make it easy to stay up-to-date in your course while covering all the course material in a reasonable amount of time. The Harvard studies have used frequencies ranging from once-a-day to once-a-week. While the course author will assign some suggested defaults settings for the course, the ultimate decision is up to you.

**What is the optimal criterion for retiring a question in an adaptive spacing course?**

Most of the Harvard studies have used the following criteria: a question is retired if it is answered correctly twice-in-a-row. We recommend using this criterion, although we acknowledge that this is not a perfect criterion for "mastery" of the content. It requires that learners demonstrate their consistent learning and retention of the material covered in a question, while allowing learners to retire all of the questions in a reasonable amount of time.

**What should I do if I fall behind in my course?**

There are several things that you can do:

1. Answer the backlog of questions --- either all at once or a few each day.
2. Put the course on vacation hold until you have more time to answer the questions
3. Re-start the course with new course settings: fewer questions delivered less frequently. If you do this, you will unfortunately lose your progress in the course.

**Can I change the course settings once I have started my course?**

Learners currently cannot change the course settings once the course has started. We are working to add this functionality in the coming months.

**I do not want to receive questions on the weekend. How can I set this up?**

This functionality is currently not available, but will be added to SpacedEd soon.

**How does a "vacation hold" work?**

A vacation hold freezes your entire course in time. You will not be sent any new questions or any review questions. You will not lose any progress in your course. The spacing intervals of already-answered questions will be prolonged by the duration of the vacation hold. To set a vacation hold, click on a course in the "Courses you are taking" section of your dashboard, and then go to the "Course Options" tab. Enter the start date and duration of your vacation.

**I no longer want to take a course I signed up for. How do I remove it?**

If you want to temporarily suspend questions for a course, you can use the vacation hold feature mentioned in the previous question. If you are sure you want to permanently drop a course, simply click on the course name on your dashboard, then select the "Course Options" tab. Click on the "Drop this course" button. You will be asked to confirm that you really want to drop the course. If you proceed, you are removed from the course and all progress information on that course is deleted.
Can I do research with the courses on SpacedEd?

Definitely Yes! We encourage you to help us learn how SpacedEd courses can best be constructed to boost learning and retention. In particular, we need to learn how best to use video and audio in the SpacedEd courses to improve the learning experience. Please share your research results with us!

[Authors]

How can I create my own SpacedEd courses?

Anyone can create their own SpacedEd course! Click on the create course button on your dashboard and use the full suite of authoring tools available on SpacedEd.

What topics are good for SpacedEd courses?

There is no limit to topics on which excellent SpacedEd courses can be created. The spaced education methodology is content-neutral and thus can be utilized to learn most anything. Potential applications range from teaching geography to school children to documenting competence in accounting skills among small business owners. While it might be a challenge to teach creative writing using the question-answer format, a whole range of topics work extremely well in this format: test preparation, language learning with embedded audio files, gardening skills with embedded YouTube videos, etc. The full multimedia capabilities of the Internet can be harnessed to create a rich and effective learning experience.

What is the best question format to use for a SpacedEd course?

Due to the limitations of the initial Harvard spaced education delivery system, the randomized trials conducted to date have only utilized the multiple-choice question (MCQ) format with one correct answer. Course authors should use the question format which best meets their needs. Each question format has its strengths and weaknesses:

- Multiple choice questions (MCQ) – Well-constructed MCQ questions with one correct answer are effective assessment tools and, due to their strong psychometric properties, have become gold-standard in educational assessment. Good MCQ questions can be very challenging to construct. Some testing organizations like the American Board of Urology spend thousands of dollars constructing each of the MCQs used on their board examinations.

- Multiple correct answer (MCA) questions – MCA questions are generally easier to write than MCQs. Another name for this type of question is ‘multiple true-false’ because the learner is forced to determine if each possible answer choice for a MCA question is correct or not. If you find yourself writing MCQs with "select all of the following, except" in the question stem or with "all of the above" as a answer choice, you might find the MCA format to be more effective.

- Fill-in-the-blank (FIB) questions – The FIB question format demands that learners perform "free recall" of the answers, unlike the cued recall needed to answer the MCQ and MCA formats. Psychology research indicates the FIB format is more effective than MCQs in generating long-term retention of learning. FIB questions are relatively quick-and-easy to write, and they can be quite challenging for the learner to answer correctly.
When writing an FIB question, the course author can choose the correct answer and several alternative correct answers. One weakness of this question format is that the learner must type in one of these answers exactly in order to correctly answer the FIB question.

Are the fill-in-the-blanks (FIB) answers case-sensitive?

No FIB answers are not case sensitive so learners do not have to match the capitalization of your answer exactly in order to get the question right. For example, if the correct answer you have specified is "Paris" both "paris" and "Paris" will be marked as correct if entered by the learner.

How can I put a hyperlink in a question or answer?

- Highlight a word which will act as the link
- Click the chain icon in the course editor
- Insert the target web address (http:// is needed before the address)
- We recommend that you select the option to have the link opened in a new window
- The "title" is what will appear when users roll-over the link
- Hit ‘save’ at the bottom of the question page
- To see how the link works, use the preview function.

How do I insert a course icon (the "album art" displayed in the catalog and on the dashboard to represent the course)?

Insert a picture into the course description page. SpacedEd uses the first picture which appears on this page as the course icon. If no picture is inserted here, SpacedEd uses the course author’s picture as the course icon. The icon will appear as a square, so it is best to choose a picture that will look good when compressed into this shape.

How do I change a course icon?

SpacedEd uses the first picture which appears on the course description page as the course icon. To change the course icon, insert a new picture on the course description page. You can delete any prior pictures if you wish.

What Are "Tags"?

Tags are one-word descriptors that you can assign to your courses, photos, and profile. Tags are a keywords you choose to help organize your stuff on this site. You can assign as many tags as you like and rename or delete them later.

How do I embed images and flash using the course editor?

You can add images or flash media to your profile and your courses by using the image and media buttons on the rich text editor.