Work-Learning Research, Inc.
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How Much Do People Forget?

WORK-LEARNING RESEARCH, Inc.

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Will Thalheimer, PhD

President, Work-Learning Research, Inc.

Will Thalheimer is a learning expert, researcher, instructional designer, business strategist, speaker, and writer. Dr. Thalheimer has worked in the learning-and-performance field since 1985.

He was the project manager for the first commercially-viable computer-based leadership simulation, The Complete Manager. He led the Strategic Management Group's product line, Leading for Business Results, increasing revenues fourfold. He has trained managers to be leaders at numerous Fortune 500 companies, teaching such topics as leadership, persuasion, conflict resolution, and business strategy. He has led change management efforts and workshops.

In 1998, Dr. Thalheimer founded Work-Learning Research to bridge the gap between research and practice, to compile research on learning, and disseminate research findings to help chief learning officers, instructional designers, trainers, e-learning developers, performance consultants, and learning executives build more effective learning-and-performance interventions and environments.

His clients have included giant multinationals, e-learning companies, government agencies, and institutions of higher learning. Short list: Walgreens, DIA, UNUM, Microsoft, MIT, Pfizer, Allen Interactions, Type A Learning Agency, eInstruction, Monitor Group, ADP, Questionmark, Midi Compliance Solutions, Facility Einstein, Defense Intelligence Agency, The eLearning Guild, Rockwell, Raytheon, Boeing, Kodak, AGFA, ASTD, AMD, PPG, Nabisco, Ericsson, Abbott, SMG, Novartis, and the U.S. Postal Service. His research and writings have led the field in providing practical research-based recommendations through his online publications, published articles, and his industry-leading blog.

Dr. Thalheimer speaks regularly at national and international conferences. His conference presentations always receive numerous evaluation-sheet comments like the following: "This was one of the best presentations I attended—solid information delivered in a style that helped me learn."

Will holds a BA from the Pennsylvania State University, an MBA from Drexel University, and a PhD in Educational Psychology: Human Learning and Cognition from Columbia University.

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Table of Contents

Executive Overview:

This report reveals four critical concepts in human learning—truths that every learning professional should deeply understand.

1. The amount a learner will forget varies depending on many things. We as learning professionals will be more effective if we make decisions based on a deep understanding of how to minimize forgetting and enhance remembering.

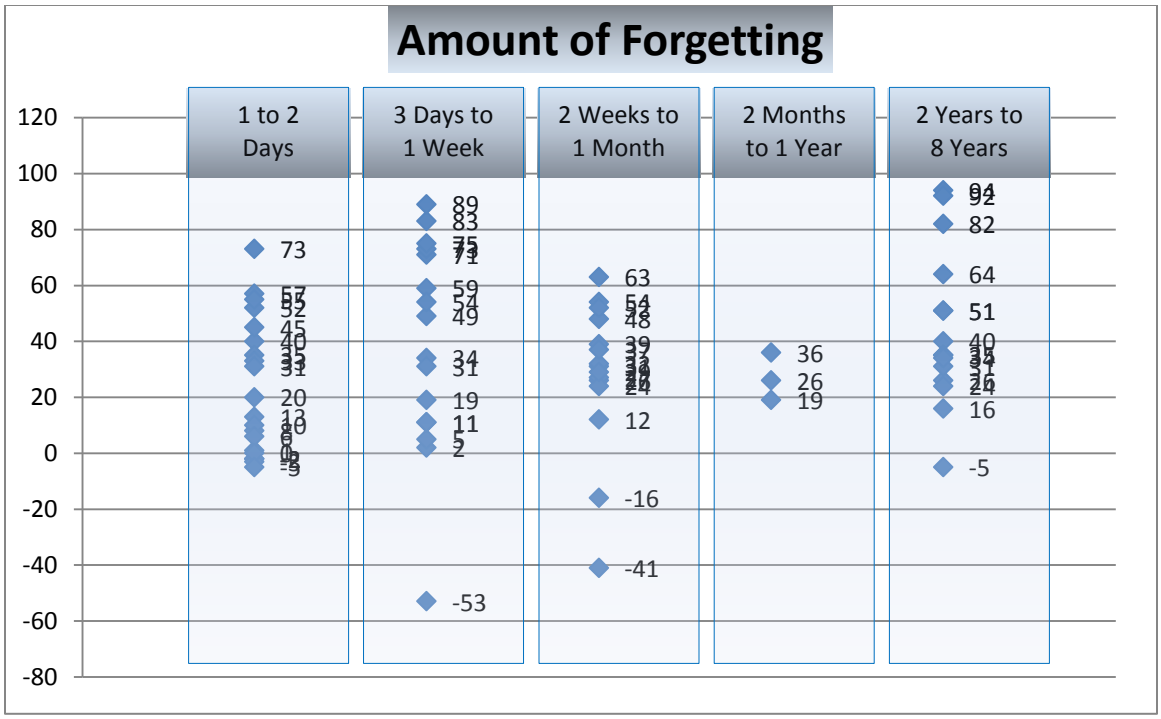
2. Rules-of-thumb that show people forgetting at some pre-defined rate are just plain false. In other words, learning gurus and earnest bloggers are wrong when they make blanket statements like, "People will forget 40% of what they learned within a day of learning it."

3. Learning interventions can produce profound improvements in long-term remembering. In other words, learning gurus are wrong when they say that training is not effective.

4. Different learning methods produce widely different amounts of forgetting. We as learning professionals can be more effective if we take a research-based approach and utilize those learning methods that are most effective.

The research reviewed in this report demonstrates very clearly that forgetting varies widely. Look at the chart on the next page. Each data point on the chart shows the amount of forgetting experienced by different learners in different experimental conditions. As you can see, in the experiments reviewed, people forgot between 0% and 94% of what they had learned. Indeed, sometimes they were even able to retrieve from memory more than before—that is, they didn't actually forget, but appeared to learn between the initial test and the subsequent test.

Even within one retention-interval range—for example having learners remember over a time period from 3 Days to 1 Week (as shown in Column 2 below)—the amount of forgetting varies widely (and wildly). Even in this one time range, forgetting is as low as 2% and as high as 89%.



Each data point in the graph above shows how much a group of learners forgot on average. These results are taken from experiments in scientific refereed journals, selected haphazardly from research articles I have previously reviewed, selected from folders in my collection that contain research on retrieval practice and the spacing effect, because it was thought that these research areas would yield experiments that utilized the "early-test, later-test" design that is essential for calculating forgetting. Bottom line: This is not a random or representative sample, but instead is a haphazard collection of research suitable to prove the point that: The Amount and Speed of Forgetting Depends!

To reiterate, the results in the above graph are not representative of all forgetting, but rather show that forgetting varies widely (and wildly) within each time range after learning. There would have to be dozens of additional studies represented to give a more robust accounting of forgetting, but the studies selected are easily sufficient to prove the main point of this report: That the amount and speed of forgetting depends on many factors.

In the remainder of this report, you will see a review of each experiment that is represented in the data in the chart above. Each experiment has its own wisdom to reveal.

Everybody Wants to Know—How Much Do People Forget?

For years, people have been asking me, "How much do people forget?" and I've told them, "It depends." When I make this statement, most people scowl at me and walk away frustrated and unrequited. I also suspect that some of them think less of me—perhaps that I am just hiding my ignorance.

But I try. I try to explain the complexity of human learning. I explain that forgetting depends on many things, for example:

- The type of material that is being learned
- The learners' prior knowledge
- The learners' motivation to learn
- The power of the learning methods used
- The contextual cues in the learning and remembering situations
- The amount of time the learning has to be retained
- The difficulty of the retention test
- Etc.

More meaningful materials (like stories) tend to be easier to remember than less meaningful material (like nonsense syllables). More relevant concepts tend to be easier to remember than less relevant concepts. Learners who have more prior knowledge in a topic area are likely to be better able to remember new concepts learned in that area. More motivated learners are more likely to remember than less motivated learners. Learners who receive repetitions, retrieval practice, feedback, variety (and other potent learning methods) are more likely to remember than learners who do not receive such learning supports. Learners who are provided with learning and practice in the situations where they will be asked to remember the information will be better able to remember. Learners who are asked to retrieve information shortly after learning it will retrieve more than learners who are asked to retrieve information a long time after learning it.

I try to explain all this, but still people keep asking.

And then there are the statistics I keep hearing—that are passed around the learning field from person to person through the years as if they were immutable truths carved by Old Moses Ebbinghaus on granite stones. Here is some information so cited (as of December 2010):

- People forget 40% of what they learned in 20 minutes and 77% of what they learned in six days (www.festo-didactic.co.uk/gb-en/news/forgetting-curve-its-up-to-you.htm?fbid=Z2IuZW4uNTUwLjE3LjE2LjM0Mzc).
- People forget 90% after one month. (http://www.reneevations.com/management/ebbinghaus-curve/)
- People forget 50-80% of what they've learned after one day and 97-98% after a month. (http://www.adm.uwaterloo.ca/infocs/study/curve.html)

Never mind that these immutable truths conflict with each other.

So, I will try one more time to convince the world that forgetting depends.

Method of Inquiry Used in this Report

This report examines 14 research articles on learning and remembering—many classic, some not. Because each article includes more than one learning condition, we will actually be looking at 69 separate cases of forgetting, representing over 1,000 individual learners.

Second, in analyzing each article I will point out how forgetting varies and what it depends on. The research cited looks at periods of forgetting from several hours to eight years. It examines learning materials that vary in meaningfulness from nonsense syllables to the kind of concepts learned in classrooms to complex tasks. It looks primarily at adult learners.

Note to non-researchers. You will see research studies from as far back as the 1917. Don't worry that some of the research is old—human cognitive machinery has not changed that much in the last 10,000 years. We still forget like we've always forgotten.

Different learning materials were utilized in the various experiments. Learning materials can be arranged on a continuum of meaningfulness from least meaningful to most meaningful (although this is not an exact science), for example as below:

1. **LEAST MEANINGFUL**: Nonsense Syllables (of the type that Ebbinghaus used)
2. Word Pairs having an arbitrary relationship (e.g., Horse, Button)
3. Knowledge and Facts that have zero or little personal relevance (e.g., "The Jajungoos are orange people who eat raisins.").
4. Word Pairs having a meaningful relationship (e.g., Cat, Gato). Gato is Spanish for cat.
5. Knowledge and Facts that hold personal relevance (e.g., "Bananas are an excellent source of potassium.")
6. Decision-Making Information (e.g., When using non-gluten flour in baking cookies, be very careful with the finished cookies, because they are more likely to crumble).
7. **MOST MEANINGFUL**: Personally-Relevant or Emotionally-Salient Information (e.g., Aunt Gertruda had a ten-month affair with one of her 15 year-old students—the one-armed lesbian albino).

Let me be clear. This continuum is NOT to be taken literally. It is only meant to illustrate the general point that some learning materials are more meaningful than others. Moreover, because different people have different experiences, interests, motivations, and triggers; a universal continuum can never be created—forgetting depends on the relationship between the learning concepts and each person's previous experiences as registered in their current memory stores.

Because it is often easier to do learning research at the lower end of this continuum, there are more experimental results for less-meaningful learning materials. This doesn't mean that the research is meaningless. It means instead, that the research must be understood in perspective. In this report, I have sampled research from all but the last category. I don't know any one-armed lesbian albinos.

Note that Hermann Ebbinghaus's work is the most cited research on forgetting, and yet his materials were almost exclusively done with nonsense syllables, which tend to be the most easily forgotten. While this report will not be a completely exhaustive review of all types of learning materials, it will at least be an improvement to the common practice of taking Ebbinghaus as the final arbiter of forgetting. Those who cite his work as predictive of real-world forgetting just don't understand.

Toward the end of this report, there is a section entitled, "Note on Forgetting Calculations," which is included for those who really want to get a deep understanding of how forgetting is measured—and also for those who want to be amused, and also for those who want to hear me scold the world with—what I hope will be—giggle-inducing prose for being so hung up on the wrong thing.

Also, toward the end of this report, there is a separate page of conclusions, another page of what the research shows, and a final section on what you should do as a learning professional (written in a manner of great seriousness).

Articles Reviewed

Each of the 14 research articles will now be examined in turn.

<table>
<tr><td>Research Study</td><td>Allen, G. A., Mahler, W. A., & Estes, W. K. (1969). Effects of recall tests on long-term retention of paired associates. Journal of Verbal Learning and Verbal Behavior, 8, 463-470.</td></tr>
<tr><td>Materials Learned</td><td>Paired Associates of the type “sun – 12” were used and learners were to learn the association so that when they were presented with the three-letter word, they had to respond with its associated two-digit number.</td></tr>
<tr><td>Time Span</td><td>1 day.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men and women.</td></tr>
<tr><td>Results</td><td>There were six conditions for which we could definitively calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A) Original Correct %</th><th>(B) Remembering Correct %</th><th>Amount of Forgetting (A – B) / A After 1 Day</th></tr>
<tr><td>10 Training Cycles
5 Initial Tests</td><td>89%</td><td>88%</td><td>1%</td></tr>
<tr><td>10 Training Cycles
1 Initial Test</td><td>93%</td><td>81%</td><td>13%</td></tr>
<tr><td>5 Training Cycles
Late in the Learning
5 Initial Tests</td><td>89%</td><td>82%</td><td>8%</td></tr>
<tr><td>5 Training Cycles
Late in the Learning
1 Initial Test</td><td>83%</td><td>66%</td><td>20%</td></tr>
<tr><td>5 Training Cycles
Early in the Learning
5 Initial Tests</td><td>61%</td><td>62%</td><td>– 2%</td></tr>
<tr><td>5 Training Cycles
Early in the Learning
1 Initial Test</td><td>61%</td><td>55%</td><td>10%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>One day after learning, learners forget from -2% to 20% on average of what they had known. Note: To understand how people can forget negative amounts, see the discussion at the end of this report entitled, “Note on Forgetting Calculations.”</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with the same material and the same learners, that forgetting can vary significantly (even after only one day). It also showed that the learning method can make a significant difference. For example, learners who got five practice trials forgot an average of 2.3%, whereas learners who got one practice trial forgot an average of 14.3%. Learners who got zero practice trials (data not shown) forgot approximately 21.7%.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Bahrick, H. P. (1979). Maintenance of knowledge: Questions about memory we forgot to ask. Journal of Experimental Psychology: General, 108, 296-308. Data here focused on the second experiment reported in the article.</td></tr>
<tr><td>Materials Learned</td><td>English-Spanish word pairs (synonyms), where learners were tested first by being presented with the English word and being asked to pronounce the Spanish word.</td></tr>
<tr><td>Time Span</td><td>1 month.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men and women with no previous experience with Spanish.</td></tr>
<tr><td>Results</td><td>There were six conditions for which we could calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %</th><th>Amount of
Forgetting
(A – B) / A
After 1 Month</th></tr>
<tr><td>3 learning sessions
0 days between</td><td>89%</td><td>33%</td><td>63%</td></tr>
<tr><td>3 learning sessions
1 day between</td><td>87%</td><td>64%</td><td>26%</td></tr>
<tr><td>3 learning sessions
30 days between</td><td>51%</td><td>72%</td><td>– 41%</td></tr>
<tr><td>6 learning sessions
0 days between</td><td>98%</td><td>68%</td><td>31%</td></tr>
<tr><td>6 learning sessions
1 day between</td><td>98%</td><td>86%</td><td>12%</td></tr>
<tr><td>6 learning sessions
30 days between</td><td>82%</td><td>95%</td><td>– 16%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>After one month, learners forgot from – 41% to 63%. Note: The negative numbers show the power of the learning method (spaced repetitions) and indicate improvement due to the effect of the last learning trial before the retention interval began. If we omitted these learning effects and just looked at the conditions where forgetting occurred, we have a range from 12% to 63% forgetting.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with somewhat meaningful learning content (much more meaningful than nonsense syllables) learners remembered a great deal of what they had learned, up to 88% after a month (or more if we include the conditions where learners actually performed better after a month than they did at the outset of the retention interval. This research also shows the power of our learning methods to minimize forgetting. Indeed, the conditions that spaced learning trials over 30 days produced virtually no measurable forgetting.

Note the experiment reported on the following page follows these same learners eight years later to see how much they'd forgotten.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Bahrick, H. P., & Phelps, E. (1987). Retention of Spanish vocabulary over 8 years. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 344-349.</td></tr>
<tr><td>Materials Learned</td><td>English-Spanish word pairs (synonyms), where learners were tested first by being presented with the English word and being asked to pronounce the Spanish word.</td></tr>
<tr><td>Time Span</td><td>8 Years.</td></tr>
<tr><td>Type of Learners</td><td>College-aged (at the beginning of the research, but eight years older now) men and women with no previous experience with Spanish.</td></tr>
<tr><td>Results</td><td>There were six conditions for which we could calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %</th><th>Amount of
Forgetting
(A – B) / A
After 8 Years</th></tr>
<tr><td>0 days between learning sessions
Free Recall Test</td><td>98%</td><td>6%</td><td>94%</td></tr>
<tr><td>1 day between learning sessions
Free Recall Test</td><td>98%</td><td>8%</td><td>92%</td></tr>
<tr><td>30 days between learning sessions
Free Recall Test</td><td>82%</td><td>15%</td><td>82%</td></tr>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %
On Either Free Recall Test or a Multiple-Choice Test</th><th>Amount of
Forgetting
(A – B) / A
After 8 Years</th></tr>
<tr><td>0 days between learning sessions
Both Tests</td><td>98%</td><td>73%</td><td>26%</td></tr>
<tr><td>1 day between learning sessions
Both Tests</td><td>98%</td><td>82%</td><td>16%</td></tr>
<tr><td>30 days between learning sessions
Both Tests</td><td>82%</td><td>86%</td><td>– 5%</td></tr>
</table></td></tr>
</table>

Overall Forgetting	On the Free Recall Test eight years later, learners forgot at a rate between 82% and 94% of their previous performance. When they got a second chance with a 5-item multiple-choice question, their performance improved radically, forgetting from – 5 to 26%. As in the original experiment, spaced repetitions produced substantial improvements in memory retrieval, for example a repetition interval of 30 days produced about twice the remembering compared to a repetition interval of only 1 day.
Lessons Learned	This research showed that even for meaningful content long retention intervals severally hurt learning, with forgetting of 82% to 94%. But it also showed that when the retrieval task was easier (a multiple choice test) some substantial memory remained even after 8 years, with one condition showing no forgetting at all—and the other conditions showing only 16% and 26% forgetting. The research also showed that learning methods matter—with widely spaced repetitions producing almost double the remembering than narrowly spaced or non-spaced repetitions.

<table>
<tr><td>Research Study</td><td>Bahrick, H. P., & Phelps, E. (1988). The maintenance of marginal knowledge. In U. Neisser & E. Winograd (Eds.), Remembering reconsidered: Ecological and traditional approaches to the study of memory (pp. 178-192). Cambridge, UK: Cambridge University Press.</td></tr>
<tr><td>Materials Learned</td><td>Three types of materials were learned, (1) general information, (2) vocabulary from a foreign language, and (3) names of famous people. However, the big difference in this experiment from most others is that all the information to-be-learned was taken from a pool of information that the learner had failed to remember previously.</td></tr>
<tr><td>Time Span</td><td>1 Month.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men and women.</td></tr>
<tr><td>Results</td><td>There were three conditions for which we could definitively calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A) Original Correct %</th><th>(B) Remembering Correct %</th><th>Amount of Forgetting (A – B) / A After 1 Month</th></tr>
<tr><td>Vocabulary Choose 1 of 4, got Feedback</td><td>59%</td><td>43%</td><td>27%</td></tr>
<tr><td>General Info Choose 1 of 4, got Feedback</td><td>59%</td><td>36%</td><td>39%</td></tr>
<tr><td>Names Choose 1 of 4, got Feedback</td><td>62%</td><td>47%</td><td>24%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>After one month, learners forgot from 24% to 39%, which means they remembered at a rate of 61% to 76% of their initial-test results.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with several types of fairly meaningful learning content (much more meaningful than nonsense syllables); learners remembered a great deal of what they had learned, up to 76% after a month. This research also shows the power of our learning methods to minimize forgetting because forgetting without the learning intervention (data not shown in table) bottomed out at 49%—compared to 24%, 27%, and 39% with the learning intervention.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Bahrick, H. P., Bahrick, L. E., Bahrick, A. S., & Bahrick, P. E. (1993). Maintenance of foreign language vocabulary and the spacing effect. Psychological Science, 4, 316-321.</td></tr>
<tr><td>Materials Learned</td><td>Foreign Language vocabulary.</td></tr>
<tr><td>Time Span</td><td>1 year, 2 years, 3 years, and 5 years.</td></tr>
<tr><td>Type of Learners</td><td>Four adults aged 25, 27, 57, and 57 at beginning of the research, all of whom had previous experience, but not recent experience, learning the foreign language of the words they were assigned to learn. Three participants were female, one was male.</td></tr>
<tr><td>Results</td><td>There were 12 conditions for which we could definitively calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A) Original Correct %</th><th>(B1) Correct % after 1 Year</th><th>(B2) Correct % after 2 Years</th><th>(B3) Correct % after 3 Years</th><th>(B5) Correct % after 5 Year</th><th>Amount of Forgetting (A – B) / A After 1, 2, 3, or 5 Years</th></tr>
<tr><td>14 day interval between learning sessions</td><td>92%</td><td>59%</td><td>55%</td><td>45%</td><td>33%</td><td>1 Yr: 36%
2 Yrs: 40%
3 Yrs: 51%
5 Yrs: 64%</td></tr>
<tr><td>28 day interval between learning sessions</td><td>84%</td><td>62%</td><td>55%</td><td>55%</td><td>41%</td><td>1 Yr: 26%
2 Yrs: 35%
3 Yrs: 35%
5 Yrs: 51%</td></tr>
<tr><td>56 day interval between learning sessions</td><td>80%</td><td>65%</td><td>55%</td><td>61%</td><td>53%</td><td>1 Yr: 19%
2 Yrs: 31%
3 Yrs: 24%
5 Yrs: 34%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>Forgetting after one year varied from 19% to 26% to 36%.
Forgetting after two years varied from 31% to 35% to 40%.
Forgetting after three years varied from 24% to 35% to 51%.
Forgetting after five years varied from 34% to 51% to 64%.</td></tr>
<tr><td>Lessons Learned</td><td>For these fairly meaningful learning concepts, forgetting varied from 19% to 64% for retention intervals of 1 to 5 years. More forgetting occurred with long retention intervals. More forgetting occurred with narrower spaced repetitions. For example, note how the narrowest spaced repetition condition produced an average of 48% forgetting, whereas the widest spaced repetition condition produced an average of only 27% forgetting, almost half as much. Learning methods matter!!</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Runquist, W. (1983). Some effects of remembering on forgetting. Memory & Cognition, 11, 641-650. Experiment 1.</td></tr>
<tr><td>Materials Learned</td><td>Arbitrarily-associated word pairs.</td></tr>
<tr><td>Time Span</td><td>1 week.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men and women.</td></tr>
<tr><td>Results</td><td>There were six conditions for which we could definitively calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A) Original Correct % (after about 15 minutes)</th><th>(B) Remember-ing Correct % (After 1 Week)</th><th>Amount of Forgetting (A – B) / A After 1 Week</th></tr>
<tr><td>Test 1: Group Not Tested, Item Tested</td><td>40%</td><td>7%</td><td>83%</td></tr>
<tr><td>Test 1: Group Not Tested, Item Not Tested</td><td>38%</td><td>11%</td><td>71%</td></tr>
<tr><td>Test 1: Group RECALL Tested, Item Tested</td><td>53%</td><td>35%</td><td>34%</td></tr>
<tr><td>Test 1: Group RECALL Tested, Item Not Tested</td><td>36%</td><td>4%</td><td>89%</td></tr>
<tr><td>Test 1: Group RECOGNITION Tested, Item Tested</td><td>60%</td><td>16%</td><td>73%</td></tr>
<tr><td>Test 1: Group RECOGNITION Tested, Item Not Tested</td><td>31%</td><td>7%</td><td>75%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>After one week, learners forgot from 34% to 89%, which means they remembered at a rate of 11% to 66% of their initial-test results. But note how one condition was far superior to all others. When learners were given a recall test two minutes after they learned the paired words, they only forgot 34% a week later, whereas the average of the other conditions produced forgetting at 78%.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with fairly non-meaningful materials (i.e., arbitrarily-associated words), learners forget a significant amount in one week. This research also showed how one learning method can produce significantly better results than other learning methods.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Krug, D., Davis, T. B., & Glover, J. A. (1990). Massed versus distributed reading: A case of forgetting helping recall? Journal of Educational Psychology, 82, 366-371.</td></tr>
<tr><td>Materials Learned</td><td>Idea units from a 600-word essay.</td></tr>
<tr><td>Time Span</td><td>1 week.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men and women.</td></tr>
<tr><td>Results</td><td>There were two conditions for which we could definitively calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A) Original Correct % (after about 15 minutes)</th><th>(B) Remember-ing Correct % (After 1 Week)</th><th>Amount of Forgetting (A – B) / A After 1 Week</th></tr>
<tr><td>Reading was the only learning intervention</td><td>34%</td><td>14%</td><td>59%</td></tr>
<tr><td>Reading plus additional immediate rereading</td><td>34%*</td><td>52%</td><td>– 53%</td></tr>
</table>
* This had to be estimated from the reading-only group.</td></tr>
<tr><td>Overall Forgetting</td><td>After one week, learners forgot 59% of what they had previously been able to recall (if they were provided with no other learning interventions initially). However, if they were enabled to reread the essay, they actually performed better than how they would have performed initially.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with fairly meaningful materials (i.e., concepts learned in reading an essay), learners forget a significant amount in one week—unless they were provided with a learning method that better supported their learning.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>di Vesta, F. J., & Smith, D. A. (1979). The pausing principle: Increasing the efficiency of memory for ongoing events. Contemporary Educational Psychology, 4(3), 288-296.</td></tr>
<tr><td>Materials Learned</td><td>21 minute lecture of approximately 2700 words.</td></tr>
<tr><td>Time Span</td><td>2 weeks.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men and women.</td></tr>
<tr><td>Results</td><td>There were two comparisons for which we could definitively calculate a measure of forgetting.
<table>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %</th><th>Amount of
Forgetting
(A – B) / A
After 2
Weeks</th></tr>
<tr><td>Free Recall Test</td><td>52%</td><td>27%</td><td>48%</td></tr>
<tr><td>Cued Recall Test</td><td>57%*</td><td>39%*</td><td>32%</td></tr>
</table>
* Had to be estimated because the article did not say how many total items were on the cued-recall test. For each calculation, the same denominator was used.</td></tr>
<tr><td>Overall Forgetting</td><td>After two weeks, learners forgot 48% on a free-recall test and 32% on a cued recall test.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with fairly meaningful materials (i.e., concepts learned in a lecture), learners forgot a significant amount in two weeks. This study also showed that the type of retrieval situation makes a difference in the level of forgetting. Here, the more difficult retrieval task—a free recall test—produced greater forgetting than the simpler retrieval task (a cued recall test).</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Gordon, K. (1925). Class results with spaced and unspaced memorizing. Journal of Experimental Psychology, 8(5), 337-343.</td></tr>
<tr><td>Materials Learned</td><td>The Athenian Oath (114 words), learned by listening to a person reading it aloud.</td></tr>
<tr><td>Time Span</td><td>1 Month in two conditions. 3 Weeks in two other conditions.</td></tr>
<tr><td>Type of Learners</td><td>College-aged students.</td></tr>
<tr><td>Results</td><td>There were four comparisons for which we could definitively calculate a measure of forgetting.
<table>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Amount of
Forgetting
(A – B) / A
After 1
Month</td></tr>
<tr><td>Six Immediate Repetitions
Recalled 1 Month Later</td><td>80%</td><td>37%</td><td>54%</td></tr>
<tr><td>3 Immediate Repetitions
3 Repetitions 3 Days Later
Recalled 1 Month Later</td><td>76%</td><td>48%</td><td>37%</td></tr>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Amount of
Forgetting
(A – B) / A
After 3
Weeks</td></tr>
<tr><td>3 Immediate Repetitions
Recalled 3 Weeks Later</td><td>54%</td><td>26%</td><td>52%</td></tr>
<tr><td>3 Repetitions Spaced
1 Week Apart
Recalled 3 Weeks Later</td><td>45%</td><td>32%</td><td>29%</td></tr>
</table>
Note: The Researcher did not randomly assign subjects to condition, but instead utilized intact classrooms to dole out the experimental treatments. This is not great methodological rigor for comparing group to group, but it is acceptable for our purposes because we are looking at forgetting within each condition, not in comparison to other conditions.</td></tr>
<tr><td>Overall Forgetting</td><td>After 1 month, learners forgot 37% and 54% of what they had learned. After 3 weeks, learners forgot 29% and 52% of what they had learned.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with somewhat meaningful materials (i.e., concept in a brief passage), learners forget a significant amount in 3 or 4 weeks.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Shebilske, W. L., Goettl, B. P., Corrington, K., & Day, E. A. (1999). Interlesson spacing and task-related processing during complex skill acquisition. Journal of Experimental Psychology: Applied, 5(4), 413-437. Experiment 1.</td></tr>
<tr><td>Materials Learned</td><td>Computer-gaming simulation.</td></tr>
<tr><td>Time Span</td><td>10 minutes, 1 week.</td></tr>
<tr><td>Type of Learners</td><td>College-aged men.</td></tr>
<tr><td>Results</td><td>There were four comparisons for which we could definitively calculate a measure of forgetting.
<table>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Amount of
Forgetting
(A – B) / A
After 10
minutes.</td></tr>
<tr><td>Practice playing the simulation was massed. Tested 10 minutes after previous learning trial.</td><td>62%*</td><td>63%*</td><td>– 2%</td></tr>
<tr><td>Practice playing the simulation was spaced. Tested 10 minutes after previous learning trial.</td><td>91%*</td><td>94%*</td><td>– 3%</td></tr>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Amount of
Forgetting
(A – B) / A
After
1 Week</td></tr>
<tr><td>Practice playing the simulation was massed. Tested 1 Week after previous learning trial.</td><td>62%*</td><td>61%*</td><td>2%</td></tr>
<tr><td>Practice playing the simulation was spaced. Tested 1 Week after previous learning trial.</td><td>91%*</td><td>87%*</td><td>5%</td></tr>
</table>
* Because performance was not based on a remembering score, but was based instead on performance as calculated by the simulation game score, there was no way to calculate a definitive “Correct Percentage.” The highest average score reported was around 3300 and though scores were still improving somewhat they appeared to be leveling off. Because of all this, I estimated an average high score of 3500 to represent the 100% mark. While this is arbitrary, it shouldn’t matter too much because both the Original Correct and the Remembering Correct would be based on the same denominator (i.e., 3500).</td></tr>
<tr><td>Overall Forgetting</td><td>After 10 minutes, learners registered virtually no forgetting, producing forgetting at -2% and -3%. One week later, learners forgot only 2% and 5%.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with a very meaningful task (i.e., simulation play), learners forgot very little either after 10 minutes or 1 week.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Singh, S., Mishra, S., Bendapudi, N., & Linville, D. (1994). Enhancing memory of television commercials through message spacing. Journal of Marketing Research, 31(3), 384-392.</td></tr>
<tr><td>Materials Learned</td><td>Advertising messages learned incidentally as contained in late-night news shows (that were edited down to 13 minutes).</td></tr>
<tr><td>Time Span</td><td>1 day.</td></tr>
<tr><td>Type of Learners</td><td>Younger and older (62-years plus) adults.</td></tr>
<tr><td>Results</td><td>There were six comparisons for which we could definitively calculate forgetting.
<table>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %</th><th>Amount of
Forgetting
(A – B) / A
After
1 Day</th></tr>
<tr><td>Younger Adults
Short Repetitions</td><td>25%*</td><td>15%</td><td>40%</td></tr>
<tr><td>Younger Adults
Long Repetitions</td><td>18%*</td><td>17%</td><td>6%</td></tr>
<tr><td>Younger Adults
No Repetitions</td><td>17%*</td><td>11%</td><td>35%</td></tr>
<tr><td>Older Adults
Short Repetitions</td><td>15%*</td><td>4%</td><td>73%</td></tr>
<tr><td>Older Adults
Long Repetitions</td><td>10%*</td><td>10%</td><td>0%</td></tr>
<tr><td>Older Adults
No Repetitions</td><td>7%*</td><td>3%</td><td>57%</td></tr>
</table>
* Estimated from subjects who were given immediate tests of memory.</td></tr>
<tr><td>Overall Forgetting</td><td>After one week, learners forgot between 0% and 73% depending on the learning method used and the age of the learner.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that with non-intentional learning of advertising messages, learners forget widely varying amounts of the content of the target commercial. This research also showed that the learning method made a significant difference. For example, when the commercial was repeated after a long spacing (where 4 other commercials were interspersed between repetitions), forgetting averaged 3%, whereas when there was a short spacing (with only 1 other commercial interspersed between repetitions) forgetting averaged 57%, and when no repetitions were provided (just a single instance of the commercial was shown) forgetting averaged 46%. Again, learning methods matter greatly! Finally, this experiment showed that different types of learners may have different amounts of forgetting. For example, the younger learners here forgot an average of 27%, whereas older adults forgot an average of 43%. Just to be clear, this finding should not be generalized to older learners in intentional learning situations—like workplace training—because the difference here could be due to older adults' better ability to filter out unwanted advertising messages.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Bloom, K. C., & Shuell, T. J. (1981). Effects of massed and distributed practice on the learning and retention of second-language vocabulary. Journal of Educational Research, 74(4), 245-248.</td></tr>
<tr><td>Materials Learned</td><td>English-French word pairs.</td></tr>
<tr><td>Time Span</td><td>4 days.</td></tr>
<tr><td>Type of Learners</td><td>High school students.</td></tr>
<tr><td>Results</td><td>There were two comparisons for which we could definitively calculate forgetting.
<table>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %</th><th>Amount of
Forgetting
(A – B) / A
After
4 Days</th></tr>
<tr><td>Spaced Practice</td><td>84%</td><td>75%</td><td>11%</td></tr>
<tr><td>Massed Practice</td><td>81%</td><td>56%</td><td>31%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>After 4 Days, learners forgot 11% or 31% depending on the learning method used.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that for somewhat meaningful learning concepts, (i.e., foreign-language vocabulary) that learners forgot a moderate amount over 4 days. This research also showed that the learning methods matter, with one learning method clearly outperforming the other learning method.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Jones, H. E. (1925). Experimental Studies of College Teaching. Archives of Psychology. New York, 68, 1-70. Experiments on pages 38-40.</td></tr>
<tr><td>Materials Learned</td><td>Classroom content on neural function, reasoning, and feeling.</td></tr>
<tr><td>Time Span</td><td>1 day, 3 days, 1 week.</td></tr>
<tr><td>Type of Learners</td><td>College students.</td></tr>
<tr><td>Results</td><td>There were six comparisons for which we could definitively calculate forgetting.
<table>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Amount of
Forgetting
(A – B) / A
After
1 Day</td></tr>
<tr><td>Tested after 1 day
Immediate Recitation</td><td>65%</td><td>68%</td><td>– 5%</td></tr>
<tr><td>Tested after 1 day
No Recitation</td><td>65%</td><td>31%</td><td>52%</td></tr>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Forgetting
After
3 Days</td></tr>
<tr><td>Tested after 3 days
Immediate Recitation</td><td>79%</td><td>70%</td><td>11%</td></tr>
<tr><td>Tested after 3 days
No Recitation</td><td>79%</td><td>40%</td><td>49%</td></tr>
<tr><td>Learning Condition</td><td>(A)
Original
Correct %</td><td>(B)
Remembering
Correct %</td><td>Forgetting
After
7 Days</td></tr>
<tr><td>Tested after 7 days
Immediate Recitation</td><td>69%</td><td>56%</td><td>19%</td></tr>
<tr><td>Tested after 7 days
No Recitation</td><td>69%</td><td>32%</td><td>54%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>Learners forgot from -5% to 54%.
For 1 day, learners forgot -5% and 52%. For 3 days, learners forgot 11% and 49%. For 1 Week, learners forgot 19% and 54%.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that for very meaningful learning concepts, (i.e., material to be learned in a college classroom) that learners forgot widely disparate amounts. This research also showed that learning methods matter, with the learning method that provided learners with recitations (retrieval practice) producing average forgetting of 8%, and learning methods that didn’t provide such recitations producing average forgetting of 52%, a substantial difference.</td></tr>
</table>

<table>
<tr><td>Research Study</td><td>Gates, A.I. (1917). Recitation as a factor in memorizing. Archives of Psychology, 40, 1-104.</td></tr>
<tr><td>Materials Learned</td><td>Nonsense syllables AND biographical descriptions.</td></tr>
<tr><td>Time Span</td><td>3-4 hours.</td></tr>
<tr><td>Type of Learners</td><td>School students, in grades 4 through 8.</td></tr>
<tr><td>Results</td><td>There were four comparisons for which we could definitively calculate forgetting.
<table>
<tr><th>Learning Condition</th><th>(A)
Original
Correct %</th><th>(B)
Remembering
Correct %</th><th>Amount of
Forgetting
(A – B) / A
After
3-4 Hours</th></tr>
<tr><td>Nonsense Syllables
20% Recitation</td><td>42%</td><td>19%</td><td>55%</td></tr>
<tr><td>Nonsense Syllables
80% Recitation</td><td>64%</td><td>43%</td><td>33%</td></tr>
<tr><td>Biographical Descriptions
20% Recitation</td><td>33%</td><td>18%</td><td>45%</td></tr>
<tr><td>Biographical Descriptions
80% Recitation</td><td>35%</td><td>24%</td><td>31%</td></tr>
</table></td></tr>
<tr><td>Overall Forgetting</td><td>Learners forgot from 31% to 55% over a period of 3-4 hours.
For nonsense syllables, learners forgot 44%. For the biographical information, learners forgot 38%. The conditions with greater recitations (retrieval practice) produced an average of 32% forgetting, while conditions with less recitation produced an average of 50% forgetting.</td></tr>
<tr><td>Lessons Learned</td><td>This research showed that for both nonsense syllables and biographical information, learners forgot a moderate amount, though slightly less for the more meaningful material. This research also showed that learning methods matter, with the learning method that provided learners with more retrieval practice producing less forgetting, 32% versus 50% in the condition with less retrieval practice.</td></tr>
</table>

Note on Forgetting Calculations

I am adding this section mostly for your amusement, but also to acknowledge the complexity of measuring forgetting, and perhaps the absurdity of this whole enterprise.

When we measure forgetting we are comparing results of a test at one time versus results of a test at a later time. We usually assume that no learning interventions are engaged in by our learners between the two tests. Otherwise it wouldn't be a fair measure of forgetting.

In this report, I calculated the amount of forgetting in the following way:

(% Correct on Initial Test MINUS % Correct on Subsequent Test) DIVIDED BY % Correct on Initial Test

Or to describe this more succinctly:

A = *% Correct on Initial Test*
B = *% Correct on Subsequent Test*

Forgetting = (A – B) / A

Interestingly, if the initial test gives the learners feedback, it, in some sense, breaks with the assumption that no learning interventions are engaged by our learners between the two tests. Why is this so? Because getting feedback is a learning intervention!

When the initial test provides feedback, it is essentially creating stronger memories than the initial test results would indicate. Let me use a fictitious measure of memory to illustrate. Suppose we measured strength of memory on a scale from 0 to 11. Let's call the unit of measurement "mems" with one unit being "a mem." Amen to that.

The 1-mem level would indicate a low likelihood of correct remembering and a 9-mem level would indicate a high likelihood of correct remembering. You're still with me right?

So, here's how the initial-test feedback might act. Let's say a learner has a 7-mem level for the rare word "fulgent." He takes our initial test and his response is consistent with having a 7-mem level of memory for the word "fulgent." But when we give him feedback on his test answer, his mem-level might go up to 8 because the feedback acts to strengthen his memory store for "fulgent." So—and here's the main point—when we test him later and he gets a test score consistent with 4-mem level of memory for the word fulgent, he will actually have forgotten more than our forgetting calculation would capture. Our forgetting score would be equal to an amount consistent with mem-levels of 7 minus 4, but he has actually forgotten 8 minus 4. In other words, we measured an initial 7, but the act of measurement itself (because we gave feedback) actually kicked the mem-level up to 8, so the learner doesn't really go from our measured 7 to 4, but goes from the measured 7 to the unmeasured 8 to 4.

Of course, real-life memory doesn't work exactly like this, but the example does show how feedback on an initial test may make a measurement of forgetting more conservative than the reality may suggest.

Given this complication, we might want to acknowledge two measures of forgetting, one for initial tests with no feedback and one for initial tests with feedback. We could use the following terms:

True-Forgetting: When Initial Test Gives No Feedback.

Under-Counted Forgetting: When Initial Test Gives Feedback.

I point this out just to make the point that measuring forgetting is difficult and to acknowledge the complications. However, I do NOT recommend using these two categories for several reasons.

- First, learners who don't get formal feedback are still getting self-generated feedback. They have some sense of how confident they are for each piece of information they recall. This has been verified in the power of the "feeling-of-knowing" concept, for example as illustrated in the Allen, Mahler, & Estes (1969) article.

- Second, forgetting scores represent net memory performance, not really forgetting per se. That is, when a learner gets 60% correct on an initial test, and 30% correct on a second test, that doesn't really mean that they forgot half of what they had previously gotten correct. Some of the 30% correct could be things he or she got wrong on the first test (not things they got right within the original 60%). Memory is actually somewhat unstable. Learners remember things they'd forgotten and forget things they previously remembered. So while most of our measures of forgetting will be reasonably accurate, we're not really measuring forgetting per se, we are measuring forgetting plus re-remembering. Let me put this in a formula to make this clear.

Measured Forgetting = Forgetting + Re-Remembering

- Third, I have so far ignored the benefits of retrieval itself—inherent in the initial-test event—which further complicates any calculations we might do. This is especially true because retrieval of correct responses tends to strengthen those memory stores a little bit (especially for information which learners hold with less confidence), and retrieval of incorrect responses tends to make correct retrieval less likely in subsequent attempts (especially if they don't receive feedback).

- Finally, I don't recommend using the two terms outlined above because the practice of quantitatively measuring forgetting is largely a dubious enterprise in the first place, which is one of the main points of this report, if you haven't noticed.

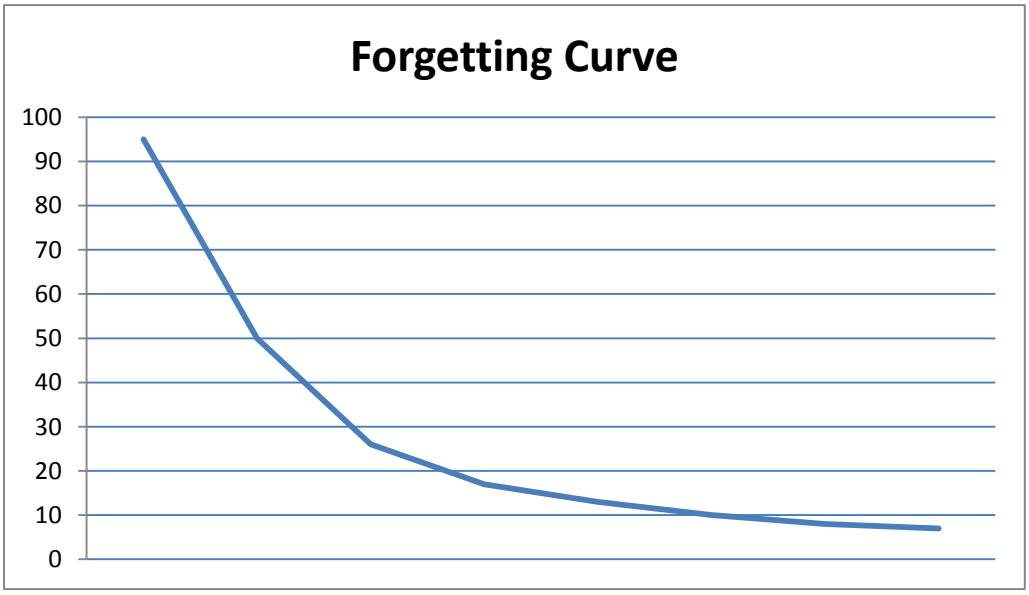
Summary of Forgetting Calculations

Too many of us believe that forgetting always follows a strict progression down an unwavering forgetting curve regardless of the learners involved, regardless of their cognitive experience, regardless of their motivation, regardless of the context of learning, regardless of the learning methods used, regardless of the type of material to be learned, and regardless of the learner's eye color. The brilliant exposition of forgetting calculations in the paragraphs above shows, above all, that measuring forgetting is first and foremost a complex and inexact enterprise—one that certainly does NOT lend itself to the algebraic certainty deployed in dubious statements like, "People forget 40% of what they learn within 20 minutes of learning it."

Should we Ignore the Forgetting Curve Notion Altogether?

The data shown in the first graph of this report—the one that shows forgetting rates that are all over the map—may lead some of us to conclude that the ideas inherent in the forgetting curve are wrong. It would be wrong to assume that those ideas are wrong.

For those of you who don't know what I'm talking about, let me provide a little background. The forgetting curve represents the idea that people forget information—ON AVERAGE—in a predictable manner. Specifically, the forgetting-curve notion asserts that learners forget lots of information shortly after learning it, but gradually the pace of forgetting slows. A typical forgetting curve is shown below:



Time is represented from left to right. Left is shortly after learning. Right is long after learning.

The forgetting curve, we must remember, is based on an average score of a group of learners, or one learner learning and forgetting many things. In reality, each piece of information may be remembered today and forgotten tomorrow—the forgetting curve just shows the average tendency. Most importantly for our purposes here, the forgetting curve represents one learning condition at several points over time, not dozens of different learning conditions each represented at single points in time (as in the research reviewed in this report).

To be practical, while we as learning professionals won't be able to predict with certainty how much our learners will forget (unless, of course, we do multiple research studies on our own learners) we can still reliably predict that our learners will be faced with forgetting of the type represented in the forgetting curve. Without intervention or application, our learners will forget a higher percentage of what they learned soon after learning and will gradually forget less and less over time.

Conclusions

This report revealed four critical concepts in human learning—truths that every learning professional should deeply understand.

1. The amount a learner will forget varies depending on many things. We as learning professionals will be more effective if we make decisions based on a deep understanding of how to minimize forgetting and enhance remembering.

2. Rules-of-thumb that show people forgetting at some pre-defined rate are just plain false. In other words, learning gurus and earnest bloggers are wrong when they make blanket statements like, “People will forget 40% of what they learned within a day of learning it.”

3. Learning interventions can produce profound improvements in long-term remembering. In other words, learning gurus are wrong when they say that training is not effective.

4. Different learning methods produce widely different amounts of forgetting. We as learning professionals can be more effective if we take a research-based approach and utilize those learning methods that are most effective.

Telling Findings from the Research:

1. People in the reviewed experiments forgot from 0% to 94% of what they had learned. The bottom line is that forgetting varies widely.

2. Even within a restricted time range, learners forgot at wildly differing rates. For example, in the 1-2 day range, learners forgot from 0 to 73%. Learners in the 2-8 year range forgot from 16% to 94%. The obvious conclusion here is that learning varies widely (and wildly) and cannot be predetermined (except perhaps by deities, of whom, I think, we have not even a few in the learning field). To be specific, when we hear statements like, "People will forget 60% of what they learned within 7 days," we should ignore such advice and instead reflect on our own superiority and good looks until we are decidedly pleased with ourselves.

3. Even when we looked at only one type of learning material, forgetting varied widely. For example, in Bahrick's classic 1979 experiment where learners were learning English-Spanish word pairs, learners forgot from 12% to 63%. Even more remarkably, if we include those cases where learners actually remembered more on the second test than the first test, learners' "forgetting" varied from -41% to 63%, a swing of 104 percentage points! Again, we must conclude that forgetting varies widely.

4. Many of the experiments reviewed in this report showed clearly that learning methods matter. For example, in the Bahrick 1979 study, the best learning methods produced an average forgetting score of -29% forgetting, whereas the worst learning methods produced forgetting at 47%, a swing of 76% points. In Runquist's 1983 study, the best learning method produced average forgetting at 34%, whereas all the other learning methods produced average forgetting of 78%. In Allen, Mahler, and Estes' 1969 experiment, the learners given the best learning methods forgot an average of 2.3%, whereas the learners who got middling learning methods forgot an average of 14.3%, and learners given the worst learning methods forgot approximately 21.7%. The bottom line is that the learning methods we choose make all the difference!!

What You Should Actually Do

What should you do, as a dedicated learning professional, as a result of understanding the crucial concepts involved in forgetting? Here's my recommended list:

1. Realize that your learners will forget. Do everything in your power to help them forget as little as possible. Also, do everything in your power to help them remember in the contexts in which it is most important for them to remember.

2. Connect with the learning research. Do your homework. Seek out experts on the research. Utilize the following three proven methods to reduce forgetting:

    a. **Aligning the Learning and Performance Contexts.**
    Help your learners learn in the type of contexts in which they will have to remember the information they are learning. Utilize context-aligned simulations, scenario-based questions, realistic practice, and similar learning methods.

    b. **Provide Retrieval Practice.**
    Ensure that your learners have practice retrieving information from memory in ways that are similar to the ways they will have to retrieve that information in critical future situations (for example, in their jobs).

    c. **Provide Spaced Repetitions.**
    Provide your learners with spaced repetitions of high-priority learning concepts, realistic practice, etc.

3. When you hear a learning guru, blogger, instructor, or even a cub-scout den mother confidently state that, "People forget X amount after X time; and Y amount after Y time…", stand up (wherever you are), seek a platform to stand on (a chair or table will do), and proclaim in a loud, resonant voice, "Hey you, pied piper of misinformation, stop telling lies! Stop undermining learning! Stop hurting learners! Stop tainting our field with an aura of quackery! If you'd ever actually looked at the research you would know that forgetting depends on many things—in fact, it is impossible to say, without knowing all the particulars of a learning situation, how much someone will forget." And, if you want to be melodramatic, you might end by saying, "Damn you Judas!" or some other appropriate damnation. Because, truly, they deserve it.

