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Online Educational Outcomes Could Exceed Those of the Traditional Classroom

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ABSTRACT

An axiom of online education is that teachers should not mechanically translate existing courses into an online format. If so, how should new or ongoing courses be reshaped for the online environment and why? The answers come both from the opportunities offered by the structure of online education and from a body of research from cognitive psychology and cognitive science that provides insight into the way people actually learn. Freed from the time and space constraints inherent in face-to-face higher education settings as well as the deeply ingrained expectations of both teachers and students, online education provides a more flexible palette upon which evidence-based ideas about learning can be integrated into course structure and design. As a result, online education can potentially deliver learning experiences and outcomes that are superior to typical face-to-face classrooms. The ability to integrate experiences that stimulate real, long lasting learning represents one of online education's greatest potential benefits.

Keywords: online learning, cognitive psychology, educational technology, innovation

INTRODUCTION

The ongoing growth of online education in higher education has led to a significant debate in higher education—is the online delivery of courses effective? Do students actually learn? Since 2012, repeated surveys have demonstrated that broadly speaking, faculty members are extremely skeptical about the efficacy of online education. A 2012 study indicated that around two-thirds of the respondents agreed with the statement that the learning outcomes in online courses were inferior to the learning outcomes in face-to-face classes, and a 2014 study revealed that only nine percent of the professoriate nationally strongly felt that online learning outcomes were equivalent to face-to-face learning. Even among those with experience teaching online, only 16 percent of the respondents felt that online learning outcomes matched those achieved in a traditional classroom setting. Faculty who had not yet taught online had an even more negative view. Only five percent believed that online outcomes could match common face-to-face methods (Shea, Bidjerno, and Vickers, 2016).

The pessimistic view of online education is deeply ironic. At the same time that faculty members are deeply distrustful of the potential of online learning, critics have questioned if learning actually takes place on campus at all. In 2011, a widely publicized study and book based on the experiences of more than 2,000 undergraduates asserted that nearly half showed little gain in critical thinking, analytical reasoning, and written communication in their first two years of their university education. Around one third did not take a single class with more than 40 pages of reading, and half did not have one class with more than 20 pages of writing assigned in it. The study called into question the rigor of college-level courses and speculated that many colleges and universities were no longer focused on undergraduate learning but had become distracted by other priorities, functions and goals (Steinberg, 2011).

Perhaps the lack of measurable student learning at traditional college campuses should not be all that surprising. Over the past 70 years, research in cognitive psychology has demonstrated that the way the learning experience is structured in most colleges and universities does not foster actual learning, nor was the structure put in place with that goal in mind. Pedagogical concerns were not primary when the contemporary university organizationally took shape around the turn of the 20th century. Instead, the objective was to establish a uniform system of education that was broadly comparable nationally. Grades, for example, were not introduced at the University of Michigan until 1913 (McKay 2017).

Many what are now standard features of a university education were introduced for reasons that had little, if anything, to do with teaching or learning. Even what has emerged as the most common academic schedule in higher education-14 to 15 week semesters with most classes meeting two to three times a week for

approximately three hours and 15 credit hours per semester being considered in full time-was rooted not in concerns about teaching and learning but in the development of a pension fund for university professors in 1906, and the desire for administrative efficiency and scientific management, which captured the spirit of that age (Silva, 2016).

In addition to the overall structure of the campus experience being shaped by factors that have nothing to do with teaching, research has demonstrated that many of the most common teaching techniques used in higher education such as 45-minutes lectures, high stakes and standardized testing, heavy homework loads and even the pacing of the learning experience itself are not conducive to learning.

On the other hand, online education frees instructors from the time and space constraints of the traditional campus experience. In asynchronous classes, students are not expected or required to appear at a fixed space at a specified hour for a defined length of time. The flexibility that asynchronous online education provides offers the opportunity to use techniques and develop educational experiences that research has demonstrated facilities long-term learning. With that in mind, it is clear that over time, online education has the potential not only to match the learning outcomes of face-to-face classrooms but also, at least theoretically, to exceed them. The vast potential for structuring online education that reflects the findings of learning science can be illustrated by reviewing five standard classrooms approaches that don't maximize learning and exploring five online learning experiences that are built on common principles of learning science that research demonstrates do lead to greater learning. This comparison is not meant to be definitive, comprehensive or exhaustive. It is not meant to suggest that the face-to-face classroom experience does not or cannot produce good results. And finally, it is not intended to propose that online education is a panacea for the challenges inherent in teaching college students. The goal is simply to identify of areas in which faculty can use online educational strategies and approaches to enhance learning outcomes. These areas ideas are not limited to being deployed in fully online or hybrid courses but using the appropriate educational technology can be integrated into the face-to-face learning experience as well.

WHAT WE KNOW DOESN'T WORK

Comparing the potential learning outcomes between online education and traditional higher education requires a working definition of learning. That is not easy as there are many different forms of knowledge and many different ways of learning. For the purpose of the comparisons made here, learning is defined as "acquiring knowledge and skills and having them readily available from memory so you can make sense of future problems and opportunities." (Brown, Roediger III, and McDaniel, 2014, pg. 3) This definition has several implications. First, learning requires the acquisition of something new, which can be either knowledge or a skill. It also calls for the ability to recall and apply that skill or knowledge from memory at an appropriate moment in the future. In other words, people can be said to have learned something when they have incorporated something that they didn't know before in a way that they can recall and apply at a moment in the future. That knowledge can be declarative or procedural. The declarative knowledge can be episodic or semantic. The procedural knowledge can be motor or mental. But the goal is for the knowledge to be stored in long-term memory and retrievable. (Kihlstrom 2013) The process of storing knowledge in long-term memory is learning. The process of retrieving knowledge from long-term memory to working memory is called remembering (Kirby, 2013).

This definition for learning is powerful in its simplicity, particularly considering the daunting statistics on memory retention. In the 1880s, the German psychologist Hermann Ebbinghaus ran a series of experiments testing how long people could remember meaningless and meaningful information. He found that people forgot around half of the information categorized as "nonsense" in his experiment within an hour and two-thirds of the information within a day (Nilsson, n.d.). Ebbinghous' experiments were seminal in the field of memory studies and eventually learning science. Many studies since have shown similar types of results. In 2014, researchers at the University of East Anglia studied 600 incoming first year students at five universities in the United Kingdom and found that they retained only about 40 percent of what they learned in high school, even though these students had done extremely well on their standardized tests (Baulkman, 2014). And a small study at the Massachusetts Institute of Technology found that students forgot approximately 50 percent of what they learned in their first year mechanics classes by the time they graduated, and students who were in majors unrelated to physics forgot about 60 percent of the material when compared to first year students who took the same test (Barrantes, Andrew, and Pritchard. 2009).

While the research on memory and the rate of forgetting seems to indicate a fairly standard pattern of how people forget-with a sharp drop in what people remember coming fairly quickly, then slowing and ultimately flattening out-the absolute rate at which people forget varies widely according to the social context and other factors including the content of what is to learned, learner motivation, prior knowledge, memory cues and so on (Thalheimer, 2010). Moreover, what any individual specifically learns or remembers from a given experience also varies (O'Conner, 2011).

Unfortunately, at least some of what takes place in the traditional university academic experience clearly does not facilitate learning (the storage of knowledge in long-term memory) nor does it aid the learning of specific knowledge that teachers want their students to learn by the close of a semester. Here are five standard features of typical college academic experience that seemingly hinder learning.

1. The Schedule of Classes

Anybody who has ever taught undergraduate students at 8 A.M. or 9 A.M. know that for many students that time is not conducive for learning. They are tired, and fatigue is the enemy of learning (Carron and Ferchuk, 1971). But early morning classes (and three-hour evening seminars for advanced undergraduates and part-time graduate students) are not the only problem. Students frequently like to schedule their classes consecutively, freeing other parts of their days for other activities. The desire for an efficient schedule has a strong logic to it, but by the time students arrive at the third or fourth class in a day, they are tired.

The timing of individual classes is not the only issue. In many undergraduate settings in the United States at least, classes meet either for 50 minute periods three days a week or for one hour and 15 minutes twice a week. Neither interval is associated with enhancing the learning process. As the psychologist and neuroscientist Jon Medina noted during his keynote address at the Online Learning Consortium International Conference in 2014, a schedule built on what is known about learning would have students repeat in the afternoon the same classes they took in the morning, which would help move information and knowledge from short-term working memory to long-term memory (Medina 2014). Nor is there anything magical about having 45 contact hours per class, per semester regardless of subject matter or learning aims. Bluntly, the overall schedule of classes for most college students in most semesters does not help learning.

2. Boring Lectures

Despite the increased focus on active learning over the past decade, the lecture, which often runs for the nearly the entire class period, remains a central so-called learning activity in many college classes. The research against lecturing as an effective way to teach is fairly overwhelming at this point. In 2014, researchers conducted a meta-analysis of 225 studies that compared the examination results or failure rates in science, technology, engineering, and mathematics (STEM) classes using active learning approaches compared to traditional lectures. The analysis found that the student performance in the active learning sections as measured by examinations results improved by six percent and students in the traditional lecture classes were 1.5 times more likely to fail than those in active learning sections (Freeman, 2014).

Those results led Harvard physicist Eric Mazur, who was not involved in the study, to reflect it's almost unethical to be lecturing if an instructor is aware of the data (Bajak. 2014). Nevertheless, lectures have been a fixture in college courses for 1000 years and they show very little sign of disappearing, particularly in large introductory courses.

3. Mass Practice

Mass practice or mass studying is what is known colloquially as "cramming." The idea, which seems to be deeply embedded into common notions of how to learn, is that if a person repeatedly exposes himself or herself to certain material, he or she will learn it. It is the way that many university students prepare for midterm and final exams. And why not? The way the traditional face-to-face classrooms are structured the midterm and final exams are the only time that students will be evaluated on their ability to retrieve specific information.

The mass-practice approach is routinely used in everything from continuing education seminars to summer language boot camps in addition to preparing for the milestone tests in a college semester. But research has shown that, while it may allow a student to perform well on a test, it does not lead to long-term learning. Mass practice has two pitfalls. First, it can produce what is called ephemeral learning, in which content is stored in short-term memory but never encoded in long-term memory. Secondly, mass practice can lead to the illusion of mastery. As students read and reread their material, they feel like they are mastering the requisite knowledge. Instead they are mindlessly repeating the material from short-term memory rather

than consolidating it in long-term memory. (Brown, et. al., 2014).

The limitations of mass practice has come to be known as Jost's Law, named after the Austrian psychologist Adolf Jost. Jost repeated the experiments by Ebbinghaus and argued that studying a new concept immediately after learning it does not have the same impact in committing it to memory as repeating it an hour or a day or a week later. (Carey, 2014)

4. Linear Structures

The idea that the instruction in a given course should start at the beginning and then systematically move forward to the end in a relatively straight line, punctuated with periodic testing and grading opportunities, seems so commonsensical that it should not warrant discussion. But learning in a linear fashion does not, in fact, foster learning.

Perhaps the most well known study to demonstrate the limitations of linear learning was an experiment in which participants were asked to study paintings by different artists and then were presented with new paintings without being told who the artist was. They were asked to determine which, if any, of the artists they had studied, in their opinion, had painted the new work. Some participants studied the artists sequentially. They learned about one artist and then moved onto the next. For others, the works of the artist were interleaved. In other words, they studied Artist A, then B, then back to A and then to C and then back to B, then back to A, then to D and so on. To the apparent surprise of both the researchers and the participants, the participants whose study of the initial set of artists was interleaved were better able to identify and appropriately categorize the unknown works. Ironically, students are so wedded to mass practice that even when it was demonstrated that other approaches are more effective for learning, they refused to accept the results. (Kornell, 2008).

5. Timed High-stakes Tests

Timed high-stakes test are also a central feature of many college and university courses and diagnostic and placement exams throughout students' educational careers. They include college entrance exams, advanced placement tests, standardized tests in high school, professional boards and licensing exams. High-stakes timed tests are flawed in several different ways. Not only do they not stimulate learning, they often also do not really measure what students actually know. Indeed, a nine year study by the National Research Council found that the move to large-scale standardized testing of the type mandated in the early 2000s under the No Child Left Behind program actually harmed educational outcomes (Hout and Elliott, 2011).

While Hout and Elliott focused on standardized testing, the same criticisms are appropriate for more mundane high-stakes timed tests like those given routinely in college classrooms. Those tests focus on a small subset of information and fail to capture the full range of student knowledge. Anticipation of the test generates anxiety for many students, which, in excess, can impede performance (ESRC 2009). Long tests are tiring, which can have an impact on performance. And the structures of many of the tests routinely discriminate against different categories of learners. Finally, one of the most common accommodations made for students is to be allowed extra time on a test. In many cases, timed tests are not testing learning or ability; they are testing performance under stress (Kim, 2011).

If these standard, fundamental structures and practices do not facilitate and potentially impede learning, why do they remain? The answer lies, at least in part, in the nature of institutions. More than a half century ago, the sociologist Arthur Stinchcombe observed that organizations reflect the organizational ideas of the periods of times in which they are founded and do not change their institutional structures unless there are compelling reasons to do so (Stinchcombe, 1965). The contemporary university emerged at the beginning of the 20th century, along with scientific industrial management ideas. The structure of the university, down to the continuing tradition of specified "office hours" in which faculty set aside specific times to meet one-on-one with students, an organizational throwback to a time before the telephone was a pervasive business tool, reflects the period of its founding.

With that in mind, the ways college schedules and classes are organized today are consistent with what was put in place 100 years ago. But online education is new and not shackled by the constraints of 100 years of tradition. Instead of reflecting the ideas of scientific management and efficiency from a century ago, ,online educational experiences can be organized around the research that links educational activities and experiences to the way people actual learn.

WHAT CAN WORK ONLINE

Distance and online education has a robust history. As far back as 1922, Pennsylvania State University offered courses via radio; barely a year after commercial radio became viable. The roots of computer-based

learning stretch back to 1960, when researchers at the University of Illinois Urbana-Champaign created PLATO, the Programmed Logic for Automated Teaching Operations (King and Alperstein). But over the past decade, rapid advances in technology has led to the emergence online educational platforms robust enough to support most, if not all, of the learning activities associated with face-to-face learning but without either the constraints of time or space. The key technological advances include the widespread availability of learning management systems; the ability to produce low-cost video and make it available to students via the Internet; near universal access to the Internet via mobile devices ranging from laptop computers to smart phones; and Cloud computing that makes many computer programs and storage available to students at no additional cost to them. Without time-and-space constraints and without the baggage of we-do-it-this-way-because-that-is-the-way-we-always-did-it that hobbles the traditional classroom, online learning activities can be structured in ways that adhere more closely to the way students learn. As these approaches are increasingly deployed, the learning outcomes realized through online education could eventually exceed those of the traditional classroom. Here are five opportunities online education offers that could foster improved learning.

1. Restructuring the Schedule

In most typical undergraduate classes, it is assumed that student should attend class for approximately three hours a week and have approximately six hours a week of homework. Rather than bunching those nine hours of instruction and research into two or three days, online education allows them to be spread over different intervals. Rather than thinking about a class and its subject matter two or three days a week, activities can be structured to require students to engage with class material five days a week. Moreover, without having to "show up" to class at a fixed time, they can attend to the material at times and places when they are better able to learn.

Loosening the class schedule and structure has two clear benefits. First, starting with Ebbinghaus, research has shown that recall aids memory and the more different times students are required to recall class content, the more likely it is that at least some of the material will pass from short-term memory to long-term memory. Secondly, since students can control when they engage in learning, in theory they can engage class material when they are mentally fresh. Moreover, when they get fatigued, they can stop and return to studying later.

2. Creating Lectures that Work

The lecture has been the centerpiece of college level education seemingly since the invention of the university and most anybody who has been to college can reflect on how difficult it is to pay attention for an extended lecture, much less take appropriate, legible notes. With low-cost video tools, individual faculty members can tape lectures in units that are more compatible with students' attention spans. Lectures segments of six to 12 minutes are emerging as a common unit. When students find their minds wondering, they can simply replay the content, which cannot be done in a face-to-face lecture. By passing control of the pace and flow of the lecture to the students, they can also take more appropriate and complete notes to enhance their learning.

But controlling the pace is only one of the many advantages taped lectures offer. Current technology allows instructors to intersperse their videos with quizzes to insure that students understand the material (or are actually watching the video). They can build intentional pauses into the lecture to allow students to reflect on the material. When content from the lectures is needed in assessment assignments in the future, students can access the lecture directly. Each of those steps improves learning (Schacter and Szpunar, 2015). Finally, in one of the most intriguing benefits, videotaped lectures can be closed captioned, which enhances the learning for both hearing students and those with hearing impairments (Linder, 2016).

3. Testing for Learning

While high stakes testing based on mass practice has been shown to be ineffective for long-term learning, repeated low-stakes testing has been demonstrated to be a very effective learning technique. The reason is that the act of retrieval from memory fosters learning.

In some ways, focusing on retrieval cuts against some of the common assumptions about learning. In general, educators start with the idea that learning takes place through the act of encoding information in memory (which explains the focus on constantly reviewing material.) Testing, in this paradigm, is a neutral event. Testing the impact of retrieval on learning over the past 10 years has led some researchers to rethink the learning process and make the argument that repeated retrieval during learning is critical to long-term learning (Karpicke and Roediger, 2007).

Online education offers teachers a much wider series of options to deploy frequent, low-stakes testing (Miller, 2014). Perhaps the most direct approach is to set up short, online quizzes that are graded automatically by the LMS. Students can take the quizzes as often as possible until they achieve a desired mastery of the material. The objective of the quizzes is not to stratify the students and assign grades but have them repeatedly retrieve from memory important content

4. Spaced and Interrupted Practice

The idea of mastering one topic prior to moving onto the next is deeply embedded in the structure of the standard college classroom. That approach is known as blocked practice. An alternative to blocked practice is what is called serial practice. In this approach, the practice of a group of skills or several clusters of information are interspersed with each other. In the study that helped establish this line of inquiry, researchers studied how a group of women learned to serve in badminton. Apparently, there are three distinct types of serves in badminton—a short serve, a long serve and a drive. The researchers divided the participants into three groups. One group practiced one serve at a time before moving to the next. The second group practiced the different serves in a specified sequence. The final group practiced the different serves in a random pattern. The researchers found the third group learned the most effectively as measured both by retention and the ability to transfer the skill to a new context. (Goode and Magill, 1986). The lapses in practice of each skill appears to provide a time for the learning to be consolidated in the participants' brains, another key learning process. Over time, the insights from that study were extended to include both verbal as well as motor learning skills.(Schmidt and Bjork, 1992).

The flexibility of a learning management system is much more amenable to interleaving course content than the rigidity inherent in time and space. It is not difficult to build learning activities that direct students back to content from previous modules. Discussion boards set up towards the end of the semester can call on information presented at the beginning of the semester. Students can even be directed to review, reflect and comment on the transcripts of discussions that occurred days or weeks earlier.

5. Connecting Learning to the Real World

One of the key findings in the classic book *How People Learn* is that students come into classrooms with preconceived notions about the way the world works, and if those initial understanding are not addressed, it makes it harder for students to grasp new information and concepts. Students may be able to repeat concepts or information for a test but the impact of the concepts and information are lost outside the classroom (Bransford, Brown and Cocking, 2000).

Almost by its very nature, the college classroom seems separate from the "real world" in many ways. On the other hand, there are several strategies for providing contextual knowledge to bolster the learning experience online. Teachers can provide short introductions to different pieces of content to place them in the context of the learning objectives of the course. Links can be provided to supplementary information demonstrating how the information they are learning comes to bear in real life. While historically colleges and universities have been portrayed as ivory towers, cut off from the world around them, in practice, that hurts learning. Connecting what takes place in the formal learning environment to students' ongoing experience of life is critical to long-term learning. To understate it, the boundaries between online educational experiences and the "real world" are very porous.

CONCLUSION

The strategies outlined above are far from exhaustive and represent the first generation of opportunities to apply the findings from cognitive psychology and learning science to improve learning outcomes. As technology improves, online technology can come to bear on many other areas of learning that are hard to address in the traditional face-to-face classroom. For example, motivation is a critical component of learning. Over time, the principles that underline computer gaming, i.e. gamification, can and will be deployed to improve student motivation to engage in educational content and learning. Along the same lines, at some point learning analytics (the analysis of data generated by students' learning experiences as well as the formal assessment mechanisms) could lead to a better understanding how students navigate specific courses and learning opportunities. Finally adaptive learning in which technology can be developed to intervene precisely when a students seems to be encountering a learning difficulty, could lead to dramatically better outcomes for individual learners and ultimately personalized learning.

Even with the current, standard technology widely available in the academy, learning experiences can be constructed that better adhere to the way people learn. As the use of those techniques proliferate, ultimately the

outcomes generated by online education could exceed those of the face-to-face classroom.

REFERENCES

Bajak, A. (2014) Lectures aren't just boring, they're Ineffective, too, study finds. Retrieved from http://www.sciencemag.org/news/2014/05/lectures-arent-just-boring-theyre-ineffective-too-study-finds.

Barrantes, A., Andrew P.l, and Pritchard, D. "What Do Seniors Remember from Freshman Physics?". AIP Conf. Proc 1179 47–50 Retrieved from http://hdl.handle.net/1721.1/76363.

Baulkman, J. (2014) First-Year College Students Forget Up To 60 Percent Of Material They Learned High School. Retrieved from http://www.universityherald.com/articles/10125/20140625/first-year-college-students-forget-up-to-60-percent-of-material-they-learned-high-school.htm.

Bransford J., Brown, A. Cocking, R. (2000) *How People Learn: Brain, Mind, Experience and School*, Washington, D.C. National Academy Press.

Brown, P., Roediger III, H. and McDaniel, M. (2014) *Make It Stick: The Science of Successful Learning.* Cambridge, MA The Belknap Press of Harvard University Press

Carron, A. and Ferchuk, A., 1971 The Effect of Fatigue on Learning and Performance of a Gross Motor Task. Journal of Motor Behavior Vol. 3:1 pg. 62-68 https://doi.org/10.1080/00222895.1971.10734893

Carey, B (2014) *How We Learn* New York, NY Random House.

Economic and Social Research Council (ESRC). (2009, June 26). Anxiety's Hidden Cost In Academic Performance. *ScienceDaily*. Retrieved from http://www.sciencedaily.com/releases/2009/06/090623090713.htm.

Freeman, S., Eddy, S., McDonough, M. Smith, M., Okoroafor, N. Jordt, H., and Wenderoth, M. P. (2014) Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Science* Vol 111. No. 23 Retrieved from http://www.pnas.org/content/111/23/8410.

Goode, S., Magill, (1986) Contextual Interference Effects in Learning Three Badminton Serves Retrieved from https://www.gwern.net/docs/spacedrepetition/1986-goode.pdf.

Hout, M. and Elliott, S. (2011) Incentives and Test-based Accountability in Education, Retrieved from https://www.nap.edu/read/12521/chapter/1.

Karpicke J., Roediger H (2007) Repeated retrieval during learning is the key to long-term retention *Journal of Memory and Language,* Volume 57 pgs. 151-162 retreived from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.558.9401&rep=rep1&type=pdf.

Kihlstrom, J. (2013) How Students Learn and How We Can Help Them. Retrieved from http://socrates.berkeley.edu/~kihlstrm/GSI_2011.htm downloaded October 25, 2017.

Kim, J. (2011) Six Reasons to End (Almost) All Timed Tests. Retrieved from https://www.insidehighered.com/blogs/technology_and_learning/6_reasons_to_end_almost_all_timed_exams.

King, E., Alperstein, N. (2014) Best Practices in Online Program Development. New York, NY. Routledge.

Kirby, J (2013) Why Don't Students Remember What They Have Learned Retrieved from https://pragmaticreform.wordpress.com/2013/11/16/memory/.

Kornell, N. and Bjorak R. (2008) Learning Concepts and Categories: Is Spacing the "Enemy of Induction," *Psychological Sciences*, retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18578849.

Linder, K. (2016). Student uses and perceptions of closed captions and transcripts: Results from a national study. Corvallis, OR: Oregon State University Ecampus Research Unit retreived from http://www.3playmedia.com/resources/industry-studies/student-uses-of-closed-captions-and-transcripts/.

McKay, T. (2017) Why Learning Analytics: How exploration of data has driven reform of the foundation courses at the University of Michigan. Retrieved from www.youtube.com/watch?v=OkmvHAR2ea0&feature=youtu.be.

Medina, Jon (2014) How Brains Learn with Technology. Retreived from http://olc.onlinelearningconsortium.org/conference/2014/aln/how-brains-learn-technology (personal communication).

Miller, M. (2014) Minds Online Cambridge, MA, Harvard University Press.

Nilsson, P. (n.d.) Retrieval and Forgetting Retrieved from http://www.senseandsensation.com/2013/03/retrieval-getting-and-forgetting-part-8.html?view=classic.

O.Conner E. (2011) What Do Student's Remember Retrieved from https://www.insidehighered.com/views/2011/03/01/essay_on_what_college_students_remember.

Schacter, D., Szpunar, K. (2015) Enhancing Attention and Memory During Video-Recorded Lectures, Retrieved from http://karlszpunar.com/Karl_Szpunar_Webpage/Publications_files/Schacter_Szpunar_2015.pdf.

Schmidt, R., Bjork R. (1992) New Conceptualizations Of Practice: Common Principles in Three Paradigms Suggest New Concepts for Training Retrieved from http://hp-research.com/sites/default/files/publications/Schmidt%20%26%20Bjork%20(PS,%201992)_0.pdf.

Shea, P. Bidjerno T., and Vickers, J. (2016) Faculty Attitudes toward Online Learning: Failures and Successes. Retrieved from http://www.sunyresearch.net/hplo/wp-content/uploads/2016/03/AERA-2016-w-new-analysis-3.pdf.

Silva, E., White T. and Toch, T. (2016) The Carnegie Unit: A Century Old Standard in a Changing Education

Landscape. Retrieved from https://www.hewlett.org/wp-content/uploads/2016/08/Carnegie_Unit_Report_2015.pdf

Steinberg, J. (2011) How Much Do College Students Learn, and Study? Retreived from https://thechoice.blogs.nytimes.com/2011/01/17/academically-adrift/?_r=0.

Stinchcombe, Arthur S. (1965) "Social structure and organizations." Pp.153-93 in James G. March (ed.), Handbook of Organizations. Chicago: Rand McNally

Thalheimer, W. How Much do People Forget Retrieved from http://www.willatworklearning.com/2010/12/how-much-do-people-forget.html

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