Teaching Tools & Techniques

Chunking as a Cognitive Strategy: Teaching Students How to Learn More in Less Time

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Purpose
To encourage the teaching of “learning how to learn” strategies to enable students to master and retain more subject matter-specific knowledge and skills in a shorter period of time than would be possible without those strategies.

Objective
Instructors can easily teach “learning how to learn” strategies (e.g., chunking, primacy, latency) to their students. Teaching these strategies to students has been shown to enhance student learning along two dimensions: (1) decreasing the amount of time students require in order to learn a set amount of subject matter-specific material, and, (2) increasing the amount of material they are able to retain post-learning. The purpose of teaching basic “learning how to learn” strategies directly to students is not simply to use these strategies for their own sake, but rather to improve student understanding by making it easier for students to master new or novel subject matter-specific material on first exposure. As is customary in the psychology of learning literature, the term “chunking” as a basic learning strategy is used to describe a wide variety of learning techniques that cover the organization of study time as well as a variety of mnemonic tools. The concept of the cognitive strategies, labeled as “learning how to learn” techniques in
this article, are also described as part of “metacognition” in Bransford, Brown and Cocking’s work *How people learn: Brain, mind, experience, and school* (1999).

**Rationale**

We want our students to learn not only from the material we present in class, but also from the readings we assign as course work. Most instructors invest significant amounts of time and effort in preparing course materials, but often feel they have too little control over how well prepared students will be to learn, much less master, the course material they present. In required courses for which there are few or no prerequisites, there is often a wide range of student abilities represented in terms of background knowledge, as well as the basic ability to learn new material. The impact of even the most carefully prepared instructional materials is lost on students who lack the ability or knowledge of how to mentally organize and “store” the materials they have been exposed to visually, orally, and/or tactiley.

As student bodies have become increasingly more diverse over the past several decades, assumptions about how well prepared students are to undertake required as well as elective courses within their major field has often required re-thinking. At a public state land grant university such as the one where I teach, I have found there to be immense payoff associated with taking a limited amount of instructional time at the beginning of required courses to equip students with learning techniques—those that have been proven to lessen the time students typically require to learn, as well as retain, new information. Many of the techniques presented in this paper are those that I have presented in the first few class sessions. The techniques presented in this paper have been selected for presentation based on their effectiveness.

Students report being discouraged (and therefore lessening their efforts), when they “worked so hard and spent so many hours studying for ‘Test X,’” but didn’t get the grade they
had expected based on their effort. Therefore, providing students with techniques such as chunking is an opportunity to increase the “payoff” students receive by using more efficient, scientifically-based study techniques. Students who perceive that their study efforts have been successful continue or even increase those efforts; those who feel their study efforts are having little effect often give up all together. While learning can be measured by a far broader set of tools than exams or course grades, these are the outcomes students cite most frequently as criteria for judging whether their study efforts were “worth it.” By making the results of their study efforts more easily visible to students by making sure they understand how to use chunking, we are helping students increase the processing efficiency of their short term memory. When students understand why chunking works, many students are motivated to use chunking to maximize their learning. Success tends to breed more effort.

Chunking is effective because it takes advantage of the fact there are limits to how much one can remember after being exposed to new material. Memory in humans involves at least three basic processes—encoding, storage, and retrieval. For human memory to work, the information we are exposed to—written text, for example—must be transformed into a meaningful form such as association with an existing memory, an image, or a sound. For example, the letters “f,” “a,” “m,” “i,” “l,” and “y,” are transformed or into the word “family.” This transformation is known as encoding. Further, the word “family” may be associated mentally with a “picture” or a memory of the reader’s brothers, sisters, mother, father, grandfather, etc.—also a form of encoding. The transformed or encoded information must then be stored, and this occurs through some physiological change that occurs in the learner in order for the memory to be stored. Then, in order to use the new information at a later point in time,
we must retrieve the memory out of storage and reverse the process of encoding—return the information to its original form prior to storage.

How information is stored in the human mind has important implications for two processes: (1) increasing the amount of information we can retrieve when we have a need to use information that we’ve stored; and (2) increasing our short term memory skills. In general, computers have only two types of storage capacity—permanent storage and permanent deletion. We humans have more complex and distinct types of memory storage capabilities, including sensory memory, short term memory, and long term memory. Sensory memory typically lasts only a few seconds and refers to any information we receive through the senses (sight, smell, taste, etc.).

Once information has entered into sensory memory it is then transferred to our consciousness or awareness (Engle, Cantor, & Carullo, 1993; Laming, 1992). When brought to the conscious or aware level, information is at the short term memory level, and represents information that is currently active such as reading the words on this page, talking to a co-worker, or writing a paper. Short term memory (STM) can last up to 30 seconds or so, and has a very limited capacity. As Miller’s (1956) classic research shows, humans can remember 7 + or - 2 bits of information, or approximately 5 to 9 bits of information in STM at any given time. If STM were limited to only a single process which lasted up to 30 seconds, humans would never get anything done. There is, however, a second phase of STM known as “working memory” which is triggered when we focus on material longer than the 30 second limit of phase one STM (Baddeley, 1992). When STM is full and yet more bits of information need to enter, displacement occurs; that is, the new information pushes out the old information. We’ve all had
the experience of forgetting the last two digits of a telephone number when we add in the area code for that number, which is an example of how displacement works.

STM can be sharpened by mastering chunking and using “rehearsal” which enables us to visualize, hear, say, or even visualize the information repeatedly and through different senses. Given STMs limited capacity, even when most efficiently used, in order to learn new material the goal is to move information from STM into long term memory (LTM) in order to maximize the potential for use of that information when needed at a later time.

Chunking in the context of cognitive psychology and mnemonics (memory systems) refers to a method of making more efficient use of STM by recoding information. In Miller’s (1956) previously cited work, he postulates that one should be able to effectively increase STM for low-information-content items by mentally recoding them into a smaller number of high-information content items. He points out that

A man just beginning to learn radio-telegraphic code hears each dit and dah as a separate chunk. Soon he is able to organize these sounds into letters and then he can deal with the letters as chunks. Then the letters organize into themselves as words, which are still larger chunks, and he begins to hear whole phrases. (p. 93)

Miller also describes the results of a 1954 experiment in which subjects were trained to listen to a string of binary digits and (in one instance) mentally group the digits into groups of five, recode each group into a name (e.g., "twenty-one" for 10101), and remember the names. With repetitive practice subjects were able to recall as many as forty binary digits. Miller went on to state:

It is a little dramatic to watch a person get 40 binary digits in a row and then repeat them back without error. However, if you think of this merely as a
mnemonic trick for extending the memory span, you will miss the more important point that is implicit in nearly all such mnemonic devices. The point is that recoding is an extremely powerful weapon for increasing the amount of information that we can deal with. (p.94-95)

The kind of recoding that Miller described is currently referred to as “chunking.”

The need to move information in STM into LTM for later retrieval makes the various types of LTM important. These types of LTM include memory for facts, life events, and information about our environment, all of which are stored in what is known as declarative memory. The latter, in turn, is made up of semantic memory, a store of factual knowledge that includes the meaning of words, concepts, and the ability to do math (Rohrer, Wixted, Salmon, & Butters, 1995) and episodic memory, which encompasses memories for events and situations (Goldringer, 1996; Kliegel & Lindberger, 1993). Although episodic memory refers to internal rather than external information (e.g., brushing your teeth, writing your name, or scratching an itch), it is still a category of memory even though it is based on repeated practice, conditioning, or habit.

One of the keys to maximizing learning, then, is to compensate for the limited capacity of STM by transferring information from STM to LTM as well as maximizing the capacity of STM itself. As has been previously stated, the use of chunking is one method of maximizing STM. The first step in getting information into STM is to transform information from sensory memory and transfer it into STM. In order to store that transferred information, one or more of six processes must occur, or specific effects be activated by the learner. These include activation of primacy effect, recency effect, distinctiveness, frequency effect, association, and/or reconstruction. Using these steps to maximize learning can be beneficial during time chunking.
**Time Chunking.** A basic use of chunking is related to how students organize their study time—specifically how many minutes each study session runs. This organization is a good clue to how much they understand about maximizing the efficiency of their learning, as well as the rate of retention of the new material they have just attempted to learn. At the undergraduate level at least, when students are asked whether one long study session (two to three hours in length) is more effective than short bursts of a series of 20 minute study sessions interspersed with very short breaks (five minutes or less), most students pick the long study session as being superior in terms of producing learning. They are, of course, wrong in this (usually strongly held) opinion, as the research on primacy and recency indicates. As we all learned in introductory psychology, the principles of primacy and recency refer to the effect that information that is encountered first is remembered more easily than information that comes later (primacy); in particular, it is the material that is in the middle, or slightly just past the mid-point of any learning session, that is most difficult to recall. Likewise, the last piece of information one encounters is remembered more easily since less time has passed since accessing it compared to earlier information (recency). We should therefore be encouraging our students to create “chunks” of study time—a series of twenty minute study or learning sessions as opposed one long two to three hour session—because by doing so multiple pairs of primacy and recency points are created, increasing the number of points of “easy” remembering. For example, a single two hour study session has two “easy” remembering points—one primacy effect point and one recency effect point; in contrast, three consecutive sessions of 20 minutes each with short (less than five minute) breaks separating each session, contain a total of six “easy” remembering points—one primacy and one recency effect for each twenty minute study segment as Figure 1 below illustrates. The six “easy” remembering points represent six chances for increased retention and
recall, as opposed to two such opportunities through a simple change in studying routine – a restructuring that requires minimal commitment but promises a significant increase in short term memory processing capability.

[Insert Figure 1 About Here]

For any student to learn more efficiently, we should not only be encouraging their use of multiple twenty minute segments of study, but also explaining why this increases retention. This information on structuring of study sessions into a series of twenty minute sessions separated by short breaks (information which can be presented in ten to twenty minutes of instructional time) can result in significant increases in student learning and retention—more learning, in less time with better retention, compared to longer study sessions so frequently preferred by many students.

Illustrating to students the benefits of adjusting the length and frequency of study sessions to take advantage of the creation of multiple recency and latency effects is closely related to other structural elements of short term memory and to the processes of moving information between short and long term memory—processes that influence student ability to retrieve information when needed for formal tests, responding in class, and other academic tasks that require information retrieval.

**Mnemonics.** Presenting a wide variety of mnemonic chunking techniques allows students not only the opportunity to practice these methods, but also to determine those with which they are most comfortable, or which seem easiest or most natural to use. A wide variety of chunking techniques are available, but some of the most basic include the use of acronyms, rhyming strategies, idea linkage, and key word associations.
Creating acronyms from lists of words that need to be remembered is a simple and effective way of memorizing. Most students are already familiar with acronyms which are words made up using the first letter of other words; thus the words “National Council on Family Relations” become the acronym “NCFR” and the “American Association of University Professors” becomes “AAUP.” The principle here is that a few letters can now represent many words, thus lightening the cognitive load for remembering. The shortening of multiple words into a single word as occurs in creating an acronym, is a simple example of the process of encoding. More complex, detailed acronym strategies can be created in order to remember longer lists of words related to any subject matter area. In research methods, for example, a student who needs to be able to easily remember a list of single group threats to internal validity), could create the following acronym “TRIMM” to stand for “Testing,” “Regression,” “Instrumentation,” “Maturation,” and “Mortality.” And although this leaves “History” out in the cold, one acronym represents five of the six single group threats to internal validity. Another useful acronym is “NOIR” (short for “film noir” or crime fiction with hard boiled cynical characters and bleak, sleazy settings,” the meaning of which often has to be explained) to stand for the four levels of Measurement – Nominal, Ordinal, Interval, and Ratio. Still another is the use of “HEAD” to represent four basic types of research as Historical, Experimental, Analytical, and Descriptive. Rhyming strategies are another long standing method for remembering facts. Countless generations of school children have learned the number of days each month has using “Thirty days has September…. The very process of looking for rhymes or patterns in words that represent concepts, or simply lists of items that need to be remembered, helps to trigger associations such as rhyming, and those associations, whether they lead to acronym formation or
the creation of rhyming patterns, are efficient memory aids that enhance remembering on
demand.

Idea linkage as a mnemonic device is even less restrictive than rhyming patterns because
it is not limited by the sound of the words or concepts one wishes to be able to recall on demand. It is an efficient means of remembering a long list of words or ideas that are not intuitively related, and is particularly useful when trying to remember a series of words would take too much time and energy to try to remember individually. In fact, the intriguing point about idea linkage is that the more novel or unique the sentence that is created using this technique, the more easily the sentence will be remembered. This extends to sentences that are downright silly or nonsensical. For example, to be able to recall the various types of validity (face, content, construct, concurrent, and predictive), one could generate the following sentence (among the many other variations possible, limited only by one’s imagination): Face is Predictive of Content when you Construct Concurrent symphonies. In general, the sillier the sentence is that’s being used for idea linkage, the easier it will be to recall. Key word associations as a method of remembering can take the form of using words or numbers and associating each word or number with the word or concept one needs to be able to recall, and is particularly useful when items or words need to be remembered in a particular order. In research methods, one such instance might be needing to remember the various types of research designs; in this scheme, a key word chosen by the learner is associated with each number “won” for the number “1,” “pair” for the number “2,” “tree” for the number “3,” and “star” for the number “4,” and so on. The important principle is that whatever idea, notion, or visual the learner naturally associates with the number is the key word that should be chosen. Then from that point onward, “won” is always the association for the number “1,” and so on. So to remember the One-shot Case Study as the first and simplest
design, the following sentence could be generated: “The One-Shot Case Study won the prize.”
Again, whatever words come to mind in the association will effect what is included in the sentence. While many students can indeed easily memorize the names of ten research designs—One-Shot Case Study, One-Group Pretest-Posttest Design, Static Group Comparison, Pretest-Posttest Control Group Design, Solomon Four-Group Design, Posttest-Only Control Group Design, Nonrandomized Control Group Pretest-Posttest Design, Time Series, Control Group-Time Series, and Equivalent Time-Samples Design – keeping them in order of complexity may be more difficult in terms of mixing up the order, especially for those designs in the middle of the series (Posttest-Only Control Group Design and Nonrandomized Control Group Pretest-Posttest Design), designs number six and seven respectively). In my system, the number “6” is always represented by “6-pack” and the number “7” by “7-up,” and thus my key word associations would be: “The Posttest-Only Control Group Design had a great 6-pack midriff,” and “The Nonrandomized Control Group Pretest-Posttest Design drank 7-up.” Giving students practice with mnemonic tools in class, applied to material that you as the instructor want them to learn anyway, gives them an opportunity to practice those methods as a means of learning your course material. They are then equipped to choose which method(s) are most effective in enhancing their learning.

**Procedure and Example**

In Introduction to Research, a required course for Human Development and Family Studies majors, after covering course requirements, I immediately proceed to the first course module, “Learning How to Learn.” I actually present students with much of the background, including research-based evidence, for “chunking” as a learning technique as well as for “primacy” and “latency.” One of the major principles I want students to adopt is the habit of
critically evaluating and questioning statements and conclusions that are presented as fact in all forms of media (including textbooks and lectures), rather than simply taking them “on faith” because some instructor, television newperson or printed ad indicates that certain things are true. Thus in asking students to understand and utilize “chunking” as a study/learning technique, I expect them to critically evaluate the research-based evidence presented by me regarding the effectiveness of these techniques, as well as evaluate the effects the use of these techniques have had on their own learning. I therefore provide in-class opportunities for students to individually evaluate their individual use of these chunking techniques with course material using in-class quizzes as one form of evaluation. As described in the “Assessing Effectiveness” section at the end of this article, this evaluation involves a comparison of the ability of individual students to recall materials studied in one class session in the following class session first without the use of chunking and then for comparable material, studied with the use of chunking (holding as many other related factors as possible constant).

The order in which the chunking information is presented, as well as the temporal positioning of quizzes I give to students as part of the in-class quasi-experiments to evaluate effectiveness, is important. The brief description below represents what I have done to introduce chunking to students and to provide data on student performance on quizzes without the use of chunking as compared to student performance using chunking as a learning technique. These pre-and-post chunking comparisons are certainly barely quasi-experimental in nature because there are no true control groups—only a within groups comparison of each student as his own control, i.e., test performance without the use of chunking versus test performance using chunking. In addition, these student groups are not randomly selected, but rather pre-formed groups of students choosing to enroll in Introduction to Research Methods. The basic method I
have used for pre-and-post comparisons, which can be used in both one and two hour class formats, is described below.

I schedule in-class time, prior to presenting any material on chunking, to conduct an in-class experiment by asking students to spend the last two hours of class time (with no study break allowed) studying a specific section of material xeroxed out of a textbook they have not seen, indicating they will be given a short quiz on this material at the beginning of the next class session. This works best for classes that usually meet only once a week and are scheduled to for 2 hours and 45 minutes. I shorten the study period to one hour of uninterrupted in-class study for classes that meet twice a week for 1 hour and 45 minutes per session. I do not allow students to leave class to study this material, explaining that this would invalidate the experiment. I collect the Xeroxed study materials as students leave class, and I do not let students leave prior to the elapse of the full two hours (or the one hour). In this manner the in-class time spent “learning” the Xeroxed material is the same for all students in the same class and, ironically, prevents additional study of this material at home which would invalidate the “equal study time” principle. At the beginning of the very next class session students are given the quiz and I record their “no study break” quiz grades.

During the next class session, I present the material on time chunking techniques for the first time, including an explanation of the importance of twenty minute study segments punctuated by five minute (or shorter) breaks, along with much of the material presented in earlier sections of this paper. In the next class session, I then provide new Xeroxed material from a different section of a textbook students have not previously seen that is of equal difficulty to the material from the no-break in-class study session. I structure the time-chunking based study sessions either as: (1) a series of three twenty-minute study segments with five minute study
breaks in between each study session (for classes that meet twice a week); or (2) a series of six twenty-minute study sessions with five minute study breaks in between each study session (for classes that meet once a week). Irrespective of the number of twenty-minute study segments involved, I again record the total number of items correct on the quiz which also occurs at the beginning of the next class session.

Once both sets of quizzes have been graded, they are returned to students so that they are able to see for themselves the effect that the different chunking techniques have had on their ability to recall in two controlled conditions: (1) quiz scores for the single “no break” long study/learning session versus the “with break” series of twenty-minute “chunked” study, with no mnemonic devices used; and, (2) non-mnemonic technique study session versus mnemonic use study session, in which the comparisons are made only under the “time chunked” (with break) study sessions of a continuing series of twenty minute study sessions punctuated by five minute (or less) breaks. A summary of the procedures I have described with respect to “time chunking” and “mnemonic devices” is in the Appendix.

Assessing Effectiveness

When each student’s scores are compared—the score on the non-time chunking quiz (long study session with no breaks) is compared to their respective scores on the time chunking quiz (series of twenty minute study sessions interrupted by five minute breaks)—statistically significant results for matched t-tests were found at the .05 level. Similar results are found when students are given new material to learn and recall under controlled conditions in-class when they are encouraged to use mnemonic devices that have been presented in class, once they have been provided the opportunity to practice using those devices during a timed in-class study session. The order of the presentation of in-class materials and quizzes is important: the
presentation of mnemonic techniques must occur after the first quiz for the non-mnemonic condition has been completed in order to avoid contaminating the non-mnemonic quiz measurement, as the numbered section under “Procedure and Example” indicates (see 1-8).

It also may be necessary to eliminate the scores on the first (non-mnemonic condition) quiz for any student(s) who indicate they used mnemonic techniques during the in-class study session which precedes the non-mnemonically based quiz (even though these techniques have not yet been presented in class) as some students may already be acquainted with these techniques. This elimination of “contaminated” quiz score(s) is easily accomplished by including a final question on the first quiz which asks each student whether any specific mnemonic techniques were used in studying the material for the quiz. This question is asked as a separate in-class handout which is not provided to students until all quizzes have been turned in, since examples of the techniques must be provided with the question, rather than relying on student understanding of what mnemonic or “memory techniques” refer to. Students should be asked to place a check mark next to any and all techniques they may have used during the study session. Quiz scores for any students who utilized any of the techniques are eliminated since there is no true “without techniques” condition for these students, and the desired comparison is a “without” (mnemonic) versus “with” (mnemonic) for each student.

It is important to acknowledge the variety of environmental factors that can influence the outcome of this 2 X 2 factorial design (see Figure 2 below). They include the possibility of intervening variables such as differences in the difficulty of the material to be learned in-class, the presence of (literal) noise in the environment that distracts students, or uncomfortable physical temperatures in the classroom, any of which could have been present in one condition of the comparison but not the other condition. Despite the threats of intervening variables, this
method of comparison at least holds the promise of a relatively objective comparison for assessing the effectiveness of chunking techniques, using each student as his or her own “control” for “with” (chunking or mnemonics) and “without” (chunking or mnemonics) comparisons.

[Insert Figure 2 here]

As shown in Figure 2, the possible comparisons which are described above are AC versus BC to measure the impact of time chunked study sessions versus no time chunking, holding the use of mnemonic devices constant, and BD versus BC to measure the impact of mnemonic devices (with versus without), holding time chunking constant for both (mnemonic and non-mnemonic) conditions.

Summary

Assuming that all or even most students come to class equipped with research-based study skills and techniques that produce the most effective, time efficient and long lasting learning effects is usually a mistake. Based on that assumption, strategies for assessing the results of introducing strategies designed to increase learning, specifically time chunking and mnemonics have been described, including the necessity to control for the difficulty and length of the materials to be learned by students class in each of the four conditions (without chunking, with chunking, without mnemonics, and with mnemonics). The use of these two study techniques results in test scores significant at the .05 level, showing the superiority of time chunking and mnemonics in terms of their contributions to student learning. Although the data resulting from these comparisons comes from a quasi-experimental design in which random assignment of students to treatments or conditions (“without” versus “with”) in which each student serves as
his/her own control, this is usually an unavoidable situation for classroom-based research conducted in a real world educational setting.

The benefits of restructuring student study routines into twenty minute segments separated by short five minute (or less) study breaks have been reviewed in the context of increasing the number of recency and primacy effects. This “time chunking” into twenty minute segments serves to increase the capacity of STM which is essential to recall and to moving information between short and LTM. This movement between STM and LTM is what allows students to retrieve information when it is needed for formal tests, class responses, and any and all academic tasks that require information retrieval. Time chunking is therefore recommended based on its ability to increase pairs of recency and primacy effects. Three 20-minute study segments produce three pairs of recency-primacy events, or a total of six “easy” remembering points. Without time chunking, the potential learner creates only two easy remembering points—a single pair of recency-primacy events by using only one long study session as opposed to multiple, short 20-minute study sessions.

Although one can never control environments completely when working in classroom settings, and even acknowledging that it is not possible to control all intervening variables that might effect the test scores used as outcome measures in this research, given the research-based evidence from the literature on metacognition, the results of this quasi-experimental design represent evidence for the desirability of instructing students in the use of time chunking and mnemomics as a means of increasing the rate of students learning and retention. In so doing, we have the opportunity to make our students more efficient, successful learners.
References


Figure 1

![Diagram showing concentration and recall over time with three 20-minute study sessions separated by 5-minute breaks, followed by an additional hour of study.](image)

Figure 2

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<th>B</th>
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<tr>
<td></td>
<td>Single long study</td>
<td>20-minute study session followed by a 5-minute</td>
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<td></td>
<td>session, no breaks</td>
<td>break, followed by a 2nd 20 minutes study session</td>
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<td>&amp; 2nd 5-minute study break, etc.</td>
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- **C**  
  No mnemonic devices used

- **D**  
  Mnemonic devices used

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Appendix

1. Step One: One or two hour in-class study session (depending on scheduled class length) with NO presentation of chunking techniques of any type,

2. Step Two: In-class quiz on material studied in previous class session (or same class session) if two hour class; scores recorded by instructor. Note that this quiz grade represents the amount of learning that occurs without the use of chunking and is the baseline score for comparison with a later quiz score based on the use of chunking.

3. Step Three: Instructor presentation on chunking as a time study technique, (“time chunking”), immediately followed by another 1 or 2 hour in-class study session. The material utilized in this study session, in which students are asked to utilize time chunking as a study technique, utilizes different material (but of equal difficulty) from the first in-class study session in Step One. It is important for the instruction to select textbook materials or articles that are of equal difficulty and length for the “without” and “with” (chunking) study sessions. The primary material covered in this presentation is summarized under the “Time Chunking,” section that follows.

4. Step Four: In-class quiz on material studied in previous class session using time chunking study techniques; scores are recorded by instructor. Scores on quizzes from Step Two (the “no chunking condition” are compared with scores on quizzes from Step Four (the “with chunking condition” to assess the efficacy of “study time chunking.”

5. Step Five: One or two hour in-class study session (depending on scheduled class length) of new material, with NO presentation of mnemonic chunking techniques of any type with study session consisting of “study break” (time chunked) model.

6. Step Six: In-class quiz on new material from Step Five above (non-mnemonic study session). This quiz score represents a second baseline of student performance, using quiz score as the outcome, of time chunking alone. This score will be compared against a subsequent quiz score which will represent the contribution of mnemonic techniques, above and beyond the use of time chunking alone.

7. Step Seven: Instructor presentation on mnemonics chunking techniques, immediately followed by 1 or 2 hour in-class study session utilizing mnemonics chunking techniques in the time chunked model.

8. Step Eight: In-class quiz on material studied in previous class session (Step Seven); scores recorded) by instructor. Scores on quizzes from Step Six and Step 8 are compared to assess the contribution of no-mnemonics versus mnemonics use to time chunking.
This article is being published posthumously. Judy Calder was a former member of the Department of Human Development and Family Studies at the University of Nevada, Reno. Please contact Karen Kopena-Frye, Ph.D., University of Nevada-Reno, Department of Human Development & Family Studies/Gerontology, MS 140, 1664 N. Virginia St., Reno, NV 89557-0140 (email: kfrye@unr.edu) with questions about the manuscript.