AN EXAMINATION OF REPETITION AND THE SPACING EFFECT IN THE CLASSROOM: A SELF-REPORT SURVEY OF TEACHERS

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ABSTRACT

AN EXAMINATION OF REPETITION AND THE SPACING EFFECT

IN THE CLASSROOM:

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Doctor of Philosophy

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The spacing effect is one of the most remarkable and reliable phenomenon to emerge from the experimental research in learning and memory. In fact, over the past 100 years it has been demonstrated with a wide range of learning paradigms, materials, and participants. Not surprisingly, several researchers have outlined suggestions for its application to the classroom (e.g., Demspter, 1988; Rohrer & Pashler, 2007). However, while it is important that educational practices are grounded in research, it is equally important that researchers consider established teaching practices when formulating experiments. This point is especially pertinent to the research on the spacing effect because despite its 100 year history, there are relatively few ecologically valid demonstrations of its effect. The primary purpose of this study was to examine the congruence between teaching practices with respect to repetition and the timing of repetitions, and research methodologies used in studies of the spacing effect. Specifically, the research objectives of this study were to investigate teachers': 1) self-reported use and opinion of repetition as a teaching strategy, 2) self-reported preferences and beliefs regarding massed versus distributed methods of teaching, and 3) self-reported

beliefs about the ecological validity of massed versus distributed teaching methods. Data for this study were gathered from 303 US teachers who completed a self-report web-based survey. While results revealed that teachers reported to use repetition in their classrooms, reported reasons for using repetition varied by grade level taught. With respect to the timing of repetitions, results indicated that teachers are knowledgeable of the benefits to memory of spaced repetitions. Interestingly, principles of the spacing effect were often reported as impractical to use in the classroom, and massed methods of teaching were overwhelmingly viewed as more ecologically valid. Results suggest the that breakdown between the research on the spacing effect and educational practice may not stem from lack of knowledge on part of the teachers, but rather from a lack of congruence between teaching practices and research methodologies. Important implications for researchers seeking to conduct ecologically valid demonstrations of the spacing effect are discussed.

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CHAPTER 1

INTRODUCTION

One common method of enhancing learning and memory for information is to use repetition; however, not all repetitions are created equal. In fact, memory is superior when the to-be-remembered information is presented in a distributed fashion (i.e., with intervening material or time between repetitions) as compared to when the information is presented in a massed fashion (i.e., with no intervening material or time between repetitions).

The benefit of memory for spaced presentations over massed presentations is not a new phenomenon. Documentation of this "spacing effect" (as it has been termed) dates as far back as the latter part of the nineteenth century with Ebbinghaus' (1885/1913) seminal work entitled *Memory*. Since this first documentation, there has been a multitude of research conducted on the spacing effect which has demonstrated not only the pervasiveness, but the reliability of the effect. In the laboratory, the spacing effect has been observed with a variety of memory tasks, to-be-remembered materials, and with participants of various ages. Much of the research on the spacing effect has investigated the theoretical mechanisms responsible for the effect (e.g., Challis, 1993; Greene, 1989), and the research surrounding these various theories is presented in Chapter 2. Other research on the spacing effect has examined the conditions necessary for the effect to occur, and several quantitative reviews have summarized the overall magnitude of the effect and have identified variables that moderate the effect (e.g., Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Donovan & Radosevich, 1999; Janiszewski, Noel, & Sawyer, 2003; Lee & Genovese, 1988; Moss, 1996). Generally these meta-analyses have

examined the spacing effect (often referred to in this literature as the distributed practice effect) in relation to verbal as well as motor and intellectual skill learning. Results of these reviews have been suggested to have important implications for organizational training programs (Donovan & Radosevich, 1999), and for research in advertising repetition and consumer memory (Janiszewski, Noel, & Sawyer, 2003).

In addition to quantitative reviews, qualitative reviews of the spacing effect have been conducted as well (e.g., Crowder, 1976; McGeoch & Irion, 1952), with several researchers outlining the need for application of the spacing effect to educational practice (e.g., Bjork, 1979; Dempster, 1987a, 1988; Naveh-Benjamin, 1990). With the implementation of the No Child Left Behind Act of 2001 and its emphasis on evidence-based practice, it would seem that applying the principles of the spacing effect to education would be of considerable value given it is one of the most highly researched phenomena in all of cognitive psychology. However, there are relatively few ecologically valid studies of the spacing effect, and thus, several researchers (Dempster, 1987a; 1988; Naveh-Benjamin, 1990) have argued that the lack of educationally relevant and classroom-based demonstrations of the effect has greatly impeded its application to educational practice. According to Dempster (1987a, 1988), paramount to conducting ecologically valid experiments is knowledge of classroom practices regarding the use of repetition. By characterizing how teachers use repetition in the classroom, researchers can formulate distribution schedules that closely resemble instruction in real-life situations, in effect, “bridging the gap” between memory research and educational practice. An increase in ecologically valid laboratory studies and classroom-based

demonstrations of the spacing effect, would likely increase its application to the educational environment.

The Present Study

While several researchers have argued for a need to bridge the gap between research on the spacing effect and educational practice, currently there are no studies that have explicitly aligned findings from studies on the spacing effect and classroom practices regarding the use of repetition. Several researchers have made assumptions regarding the use of the spacing effect in the classroom, proposing that it conflicts with established teaching habits. For example, Bjork (1979) and Dempster (1987a) suggested that instruction is characterized by a lack of repetition and that repetitions, if they occur, are usually massed. That is, a teacher presents topic or concept, repeats it a few times in succession, only to never return to the concept again. However, there is no direct empirical evidence that this is in fact how repetitive instruction occurs in classrooms at the present time.

In light of this discussion, the primary purpose of this study was to investigate the spacing effect with respect to teachers' self-report of established practices of repetition and distributed instruction as a teaching strategy. This research goal is not only critical to understanding the current state of application of the spacing effect to education but it can guide applied research in this area by identifying where gaps exist between research and practice. Only by understanding and defining this gap can researchers begin to create studies that are ecologically valid. The specific objectives of this research are threefold:

1) To investigate teachers' self-reported use and opinion of repetition as a teaching strategy

2) To investigate teachers' self-reported preferences and beliefs regarding massed versus distributed methods of teaching

3) To investigate teachers' self-reported beliefs about the ecological validity of massed versus distributed teaching methods

The methodology for this study utilized survey research. Teachers from across the US were surveyed via a self-report web-based instrument regarding the aforementioned research objectives. Based on pilot research (Kiepert Truong & Thurman, 2008) presented in Appendix A, it was predicted that the majority of teachers would self-report using repetition as a teaching strategy, and perceive it as practical and effective. Most importantly, however, it was predicted that teachers would report knowledge of the spacing effect (i.e., that spaced repetitions are more beneficial to learning than massed repetitions); however, with respect to instructional reinforcement (such as homework) it was predicted that teachers would actually prefer to use a massed method (or a less distributed method). Finally, it was anticipated that teachers would view massed teaching methods as more ecologically valid than spaced teaching methods.

CHAPTER 2

LITERATURE REVIEW

Theoretical background of the spacing effect

Although the spacing effect is a robust phenomenon, there is no one theory to account for its effect. Theories of the spacing effect fall into one of several general categories, with most theorists supporting a deficient-processing or encoding variability account of the spacing effect (Hintzman, 1974), while others have supported a study-phase retrieval mechanism (e.g., Braun & Rubin, 1998; Verkoeijen, Rikers, & Schmidt, 2004), or a two-process theory which suggests that the processes accounting for the spacing effect are task and circumstance specific (Challis, 1993; Greene, 1989).

Deficient-Processing Theories

According to a deficient-processing account of the spacing effect, repetition increases the total amount or quality of processing devoted to the to-be-remembered materials. The spacing effect occurs because as the spacing between items or information increases, there is a greater probability for both presentations to receive adequate processing. On the contrary, massed repetition results in poorer memory for to-be-remembered information because it causes inadequate processing of one presentation (either the first or the second) (Shaughnessy, Zimmerman, & Underwood, 1972). There are several variations of deficient processing theory, namely attenuation of attention (Shaughnessy, et al., 1972; Zechmeister & Shaughnessy, 1980), habituation theory (Hintzman, 1974), consolidation theory (Landauer, 1969), and level-of-processing theory (Craik & Lockhart, 1972; Rose & Rowe, 1976). While these theories not only differ on the involuntary or voluntary nature of the underlying mechanism, they differ as

to when the deficient processing occurs, that is, either during the inter-repetition (between the first and second presentations), or during the second presentation.

Attenuation of attention. This version of deficient-processing theory asserts that a voluntary attention process is responsible for the effect. Spaced items are remembered better because more attention is devoted to a spaced item (Shaughnessy, Zimmerman, & Underwood, 1972). On the contrary, when study is massed, less attention is devoted to the second presentation of an item because the item can be easily retrieved from memory since it was just presented (Zechmeister & Shaughnessy, 1980).

Habituation theory. According to habituation theory, the underlying processes responsible for the spacing effect occur involuntarily or automatically. Poorer processing of massed items is due to a habituation process, as the name suggests (Hintzman, 1974). That is, presentation of the first item causes lower responsiveness to the second presentation. Thus, when items are massed, responsiveness is much lower to the item than if items are spaced since the passage of time allows for the recovery of responsiveness. In spaced items, since time has allowed increased responsiveness to the second presentation of an item, memory is greater than when the item is massed.

Consolidation theory. In this version of deficient-processing theory, automatic processes are responsible for the effect as well as interference with a consolidation process. The consolidation process functions to turn a possible memory trace into a retrievable one. In massed presentations the consolidation process of one item interferes with the consolidation process of another. Memory for spaced items is better because the consolidation process is more nearly completed by the time the second presentation occurs (Landauer, 1969).

Level-of-processing theory. According to Craik and Lockhart's level-of-processing theory (1972), the deeper the level and quality of processing, the greater the memory. Thus, a level-of-processing account of the spacing effect suggests that a spacing effect occurs because the second presentation of a massed item is not processed as deeply as it is in a spaced presentation (Rose & Rowe, 1976).

Encoding Variability Theory

Encoding variability theory explains the spacing effect as the result of the differences in encoding processes which occur during the first and second presentations of an item (Glenberg, 1976). According to encoding variability theory, the spacing effect occurs because as the spacing between items increases, there is greater opportunity for the first and second presentations to be encoded in memory differently which increases the probability of retrieval during the test phase. Variations of encoding variability theory include differential organization theory (Glenberg, 1977), contextual variability theory (Glenberg, 1979), and stimulus-sampling theory (Bower, 1972; Glenberg, 1976). Numerous studies have provided empirical support for encoding variability theory (Delarosa & Bourne, 1985; Glenberg, 1979; Krug et al., 1990; Madigan, 1969; Verkoeijen et al., 2004).

Differential organization theory. In this version of encoding variability theory, a voluntary process based on the organization between items is believed to be responsible for the effect (Glenberg, 1977). As spacing increases between items, there is greater opportunity for the items to be organized into different groups in memory, which allows for more ways that the item can be retrieved from memory.

Contextual variability theory. According to this highly researched theory, elements of the context (e.g., testing environment, time of day, thoughts & feelings, etc) are automatically encoded into memory with the presentation of an item. The spacing effect occurs because as spacing between items increases, there is more opportunity for different contexts to become encoded into memory, allowing for more ways to retrieve them (Glenberg, 1979).

Stimulus-sampling theory. In this automatic process account of the spacing effect, the item itself is represented differently in memory with each presentation (Bower, 1972; Glenberg, 1976). Aspects of the context change the participant's perception of the item, and as spacing increases, the more likely it is that context will change, producing a change in the perception of the item.

Study-Phase Retrieval Theory

Another less common theory of the spacing effect is study-phase retrieval. According to this theory, the second presentation of an item serves as a retrieval cue for the first (Thios & D'Agostino, 1976). The spacing effect occurs because there is more similarity between retrieval processes during the study and test phases when items are spaced as compared to when they are massed. Study-phase retrieval is often thought to occur automatically although it may come under voluntary control in certain circumstances. Evidence for a study-phase retrieval mechanism has been obtained in several studies (Braun & Rubin, 1998; Toppino & Bloom, 2002; Toppino, Hara, & Hackman, 2002; Verkoeijen et al., 2004).

Two-Process Accounts

While deficient-processing theories, encoding variability and study-phase retrieval theory can account for much of the data on the spacing effect, most recently, research has indicated the mechanism responsible for the spacing effect is contingent on the memory task. That is, one process may be responsible for the effect in cued-memory tasks (e.g., recognition, frequency judgment, cued recall), while different processes are responsible for the effect in free recall. The multi-process account of the spacing effect first began with Greene (1989) who suggested that with cued-memory tasks a voluntary deficient-processing mechanism is responsible for the effect, while an automatic encoding variability mechanism is responsible for the effect in free recall. Subsequent research on Greene's two-process theory has investigated the involvement of semantic priming, suggesting that an *involuntary* rehearsal strategy is responsible for the spacing effect in cued- memory tasks, particularly when semantic processing of the to-be-remembered items is manipulated (Challis, 1993). Additional research, however, on the spacing effect in cued-memory tasks is inconsistent with Challis' (1993) semantic priming account and suggested that transfer appropriate processing is the mechanism responsible for the spacing effect (Russo & Mammarella, 2002). With respect to free recall, recent research has indicated that study-phase retrieval mechanisms as well as contextual variability mechanisms are responsible for the effect with this type of memory task (Verkoeijen et al., 2004).

Relevance of Theories to Educational Practice

One of the largest differences among these theories, with respect to relevance to educational practice, is their pertinence to educational tasks. Encoding variability theories stress encoding processes, which in turn, affect retrieval cues. In spaced practice, these

retrieval cues aid memory better than in massed practice. Thus, the focus on encoding and retrieval suggests that encoding variability theories might be used to explain study methods or habits which will produce the best test performance. In other words, encoding variability theories may be used to explain how a student can best encode the information so that it is easily retrieved during a test or exam, and several researchers have investigated encoding variability theories in this manner (e.g., Dempster, 1987b; Smith & Rothkopf, 1984). On the other hand, in deficient processing theories the focus is more on the rehearsal processes, as opposed to retrieval processes, and thus may seem to lend themselves to educational studies that focus on how *well* information is learned (i.e., the depth and quality of understanding). Deficient processing theories may be used as the basis for educational studies that use problem-solving tasks rather than free or cued recall (where encoding variability theories may best explain the effect).

Application of the Spacing Effect to Educational Practice

Although there is not a unitary account of the mechanism responsible for the spacing effect, the research suggests that this phenomenon is highly robust and very well documented over the past century (for reviews see Hintzman, 1974; Glenberg, 1979). For example, spacing effects have been consistently shown in tests of free recall (e.g., Greene, 1989; Glenberg, 1977; Verkoeijen, et al., 2004), cued recall (e.g., Braun & Rubin, 1998; Challis, 1993; Greene, 1989; Russo & Mammarella, 2002; Russo, Parkin, Taylor, & Wilks, 1998), and with intentional and incidental learning tasks (e.g., Greene, 1989). Evidence of the spacing effect has been found using a wide range of materials such as words (e.g., Greene, 1989; Glenberg, 1977), pictures (e.g, Hintzman, Summers, & Block, 1975; Toppino, 1991), phrases (e.g., Thios & D'Agostino, 1976), faces (e.g.,

Carpenter & Delosh, 2005; Russo et at., 1998), sentences (e.g., Underwood, 1970), and text passages (e.g., Krug, Davis, & Glover, 1990). In addition, consistent spacing effects have been obtained with a wide age range of participants including infants (e.g., Cornell, 1980), children (Rea & Modigliani, 1987; Toppino, 1991), young adults (e.g., Smith & Rothkopft, 1984), and even the elderly (e.g., Balota, Duchek, & Paullin, 1989).

In light of the pervasiveness of the spacing effect, it would seem that it could have the potential to influence how teachers use instruction and instructional materials to improve student learning. According to Dempster (1987a), however, reservations about applying the spacing effect to the classroom usually stem from the counterintuitive nature of the effect, the lack of ecologically valid experiments, and the fact that some applied studies of the spacing effect have produced mixed results. For example, an experiment using experienced educators found that massed repetitions of prose were rated as better than spaced repetitions of prose with regard to instructional effectiveness (Rothkopf, 1963). In addition, the vast majority of experiments on the spacing effect use methodologies that are not particularly analogous to learning as it occurs in the classroom. In the most traditional laboratory studies of the spacing effect (such as those discussed in the theory section), the most popular method of demonstrating the spacing effect is through the use of word lists (or alternatively lists of pictures, phrases, or faces). Within these lists, certain positions are reserved for massed and spaced items (as well as primacy and recency buffers), and a subject usually sees a number of lists in which these positions have been counterbalanced. If memory is superior for the spaced items as compared to the massed items within the list (either on a test of free or cued recall), then a spacing effect has occurred. While this methodology is internally valid, it limits the

application of this effect to real world situations since students rarely, if ever, are presented with classroom information in a similar manner. If educators are going to utilize the findings from the spacing effect research, then more attention needs to be devoted to the issue of verisimilitude, or how closely the tasks required by an experiment resemble the types of tasks occurring in day-to-day functioning (Frazen & Wilhelm, 1996).

While there are studies on the spacing effect using classroom-relevant materials, they have often yielded mixed results. For example, studies have found spacing effects using materials such as multiplication facts (Rea & Modigliani, 1985), however, several other studies have failed to obtain spacing effects with materials such as paraphrased sentences (Dellarosa & Bourne, 1985), paragraphs (Glover & Corkill, 1987; Krug, et al., 1990), and tape-recorded lectures (Glover & Corkill, 1987). That is, in each of these studies, verbatim materials yielded the traditional benefit of spaced repetitions, but when the repetitions were paraphrased, the massed repetitions performed as well as the spaced repetitions. These findings are critical to the use of the spacing effect in the classroom, not only because they place very specific limitations on the conditions needed for the effect to occur, but it is likely that paraphrased repetitions are much more frequent than verbatim repetitions in actual classrooms. Another applied study found that spacing effects may be contingent on individual difference factors (Riches, Tomasello, & Conti-Ramsden, 2005), while this finding was not supported by Rea and Modigliani (2005) who found spacing effects regardless of ability level. Additionally, in a classroom intervention study, Moss (1996) suggested that massed presentations may yield greater learning than spaced presentations.

Ecological Validity and the Spacing Effect

A dominant theme from the qualitative reviews on the spacing effect that deserves more attention in this context is the relationship between ecological validity and the spacing effect since several researchers assert that the lack of ecologically valid studies is the largest impediment to application of the effect to educational practice. For example, Dempster (1987a) claims that:

> the product [of experiments] must be applicable to classroom learning activities. If it cannot be demonstrated that the product generalized beyond the artificial domain of the laboratory, it will seem to have little relevance to the classroom. Such demonstrations are in fact, the most important bridge between basic research and educational practice (p. 15).

Likewise, a similar theme is evident in another article from Dempster (1988):

> The most serious of the plausible impediments to the application of the spacing effect is the paucity of impressive classroom demonstrations of the phenomenon. Clearly, programmatic research on the effects of spacing in education settings is long overdue, as the results of such efforts would likely aid in its application (p. 632).

Naveh-Benjamin (1990) outlines several benefits of conducting ecologically valid research on the spacing effect suggesting that: 1) it can demonstrate that principles established in the laboratory are relevant to education, 2) it can add confidence to using these principles in several domains including instruction, course and curriculum design, and learning, 3) it could expand the results of laboratory-based study by showing particular limitations of the effect, 4) it can have theoretical implications for the spacing effect, and 5) ecologically valid studies of the spacing effect can provide important information about variables not studied in traditional laboratory experiments of the spacing effect (e.g., problem-solving tasks).

Given this rationale, ecologically valid demonstrations of the spacing effect are a critical factor in the relationship between the spacing effect and education. Review of the literature shows that there have been a handful of studies on the spacing effect that have used ecologically valid materials in a controlled setting, but to date, there have been only a few demonstrations of its effect in actual classroom settings.

Educationally relevant studies of the spacing effect in controlled settings. Research on the spacing effect has included educationally relevant materials. For example, Reynolds and Glaser (1964) used programmed instruction to vary review of biology concepts. In this experiment, junior high students (who were matched on intelligence and a biology pretest) were taught via a computer program, several lessons on biology. In the massed conditions, review of the experimental lesson immediately succeeded the presentation of the experimental lesson, while in the spaced conditions review of the experimental lesson occurred after presentation of other learning tasks. Students were tested using free recall, cued-recall, and recognition (i.e., multiple choice) tests of biology terminology. Results indicated that spaced review facilitated learning of the experimental biology lessons compared to massed review.

Fishman, Keller, and Atkinson (1968) tested the effects of spacing presentations of spelling words. Through a series of computerized spelling drills, fifth grade subjects were asked to spell words in either 2 sets presented over 6 days, or 6 sets within one single day. Results supported a spacing effect such that during test phase, either 10 or 20 days later, the words that had been practiced via spaced trials were better remembered than those practiced via massed trials.

Another study with relevance to educational practice used vocabulary learning to examine a contextual variability hypothesis of the spacing effect (Dempster, 1987b). In a series of five experiments, participants were given booklets that contained vocabulary words and definitions on each page. In the massed conditions the vocabulary words were presented in succession, while in the spaced conditions the vocabulary words were presented at a lag of 37 (i.e., there were 37 other vocabulary words between repetitions). In order to test a contextual variability hypothesis, some of the vocabulary words were used in context. College-aged participants were instructed to study each word for 20 seconds, and at the end of the study phase, participants were given a test of free recall. Results of these experiments did not provide evidence for a contextual variability hypothesis, however, the spaced vocabulary words were recalled better than the massed words. In some instances, the number of word meanings recalled was over 50% greater for the spaced conditions compared to the massed.

The spacing effect has also been demonstrated with multiplication facts and spelling lists using third grade participants (Rea & Modigliani, 1985). In this experiment, children were grouped according to their multiplication and spelling abilities. Results showed large gains in retention of both multiplication facts and spelling lists in the spaced conditions as compared to the massed, regardless of the ability level of the child. With multiplication facts, retention in the spaced condition was nearly twice that of the massed condition.

Spacing effects with paraphrased materials have produced mixed results. In a study conducted with college students, Reder and Anderson (1982) found that recall of ideas for paraphrased summaries of text was superior to knowledge acquired from

rereading the original prose. According to these researchers, the summaries allowed the participants to reread important main ideas at spaced intervals, producing better recall. However, as mentioned previously, there is some evidence to suggest that paraphrased sentences (Dellarosa & Bourne, 1985), paragraphs (Glover & Corkill, 1987; Krug, et al., 1990), and tape-recorded lectures (Glover & Corkill, 1987) do not always produce spacing effects.

While the majority of the spacing effect studies examine the effect within a relatively short time frame between learning trial and test phase, Bahrick, Bahrick, Bahrick, and Bahrick (1993) examined the long-term effects of spaced study with a longitudinal design using foreign language learning (specifically vocabulary). In this study, four subjects were trained in sessions that occurred either in intervals of 14, 28, and 56 days. Retention was tested at intervals of 1, 2, 3 or 5 years after the initial training was completed. Results supported the benefits of spaced retrieval to the maintenance of foreign language vocabulary.

More recently, researchers have examined the spacing effect with word learning in young children (Childers & Tomasello, 2002; Riches, et al., 2005). For example, in Childers and Tomasello's study (2002) two-year-olds were taught novel nouns and verbs during individual play sessions. Presentation schedules (or "exposures" to target words) were either massed with four or eight exposures in a single day, or spaced with one exposure per day on 4 consecutive days or one exposure per day with 3 intervening days. This study also included a comprise condition between the massed and spaced conditions such that children received either two exposures on one day and two exposures on another day, 3 days later, or two exposures on 1 day, four exposures 3 days later, and two

exposures 3 days after that. Results indicated that timing of exposures was critical to learning new words such that for both nouns and verbs, production was worst in both of the massed conditions. The number of different days of exposure was found to be the key timing variable such that more days facilitated learning.

In a similar study that used educationally relevant materials in a controlled setting, Riches et al. (2005) examined the effect of spacing presentations on verb learning. In this experiment frequency and spacing was manipulated with two groups of children, those with specific language impairment (SLI) and those without. Results indicated that children with SLI (ages 5 to 6) benefited more from presentations of words over four days as opposed to multiple presentations of words on a single day. However, a spacing effect in this experiment was not found with the normal language children (ages 3 to 4, matched for language ability).

One recent study that has investigated a unique aspect of the spacing effect is particularly relevant to education. Son (2004) investigated participant-controlled lag time (i.e., a metacognitive strategy). Previous studies of the spacing effect up to this point in the literature had controlled the amount of time (or delay) between study and test, while Son's study allowed the participants to judge whether they wanted to study an item immediately or at a later time. This methodology has clear relevance to education considering students often prepare (i.e., study) for exams using metacognitive strategies. In Son's experiment, a "metacognitive hypothesis" was tested which suggests that if an item is believed to be well learned, participants will chose to study this item later. On the other hand, when presented with an item that is judged to be not well learned, participants will choose to study it immediately. Results of this study not only provided support for a

spacing effect, but they also supported the metacognitive hypothesis. According to the findings of this study, it might be useful for educators to teach a new metacognitive study strategy such that when information is judged to be difficult to learn, students should use a spaced study strategy (given the benefit of memory for spaced items), which will in turn increase learning of that information.

Finally, most recently, Rohrer and Taylor (2006; 2007) have demonstrated spacing effects with undergraduates using mathematics learning, particularly the spacing of mathematics practice problems. In these studies, distributed practice yielded a greater benefit to long term retention than massed practice.

Classroom-based studies of the spacing effect. Several classroom-based studies of the spacing effect have compared long sessions of instruction with frequent shorter sessions. In one of the most ecologically valid studies of the spacing effect conducted to date, Smith and Rothkopf (1984) used videotaped statistics lectures and varied the distribution of the lectures between two groups of students that were matched on a mathematics pretest. Students were tested via free recall, cued-recall, and a problem solving task (i.e., a task with clear analogies to the classroom). Spacing effects were found such that students who received distributed instruction (i.e., instruction dispersed over the course of 4 days) performed better on a tests of statistics as compared to students who received massed instruction (i.e., instruction presented in 1 day); however, the spacing effect was contingent on the memory task used during the testing phase. Interestingly, effects were not observed using the problem solving task, the most ecologically valid condition. It is worth noting, however, that the researchers did not counterbalance the presentation of the memory tests, with the problem solving task

always presented as the last task. Thus, it is unclear whether the lack of a spacing effect in this condition was due to carry over or fatigue effects.

Moss (1996) examined the effect of practice schedule (massed versus spaced) on verbal and mathematical learning tasks in second and fourth grade classrooms. For a course of nine weeks, these classrooms were assigned an "integrated learning system" intervention in which they either followed a spaced or a massed practice schedule. Results of this study did not support a spacing effect, and although statistically significant results were not found, the data actually suggested that massed practice was more beneficial, particularly for massed intellectual skills such as mathematics learning.

While Moss (1996) may not have found support for a spacing effect using mathematics materials, Revek (1997) found that for low achieving mathematics students, a distributed homework schedule was more beneficial to mathematics (Pre-Calculus) achievement than a massed homework schedule. A massed homework schedule was one that was characterized by a "vertical model" for assigning homework such that homework assigned on any given day directly corresponded to a topic covered in class that same day. A distributed homework schedule combined practice on current topics (i.e., those presented that day) with reinforcement from topics covered previously in class. In a similar study on high school students' achievement in geometry, Yazdani and Zebrowski (2006) also found that a distributed homework schedule enhanced achievement more so than a massed homework schedule.

In another classroom-based study, Seabrook, Brown, and Solity (2005, experiment 3) demonstrated a benefit of distributed over massed practice with elementary-aged children. Using a procedure relevant to education, Seabrook et al. used a

‘clustered’ distribution presentation (rather than the traditional massed presentation) in which differing degrees of distribution were compared. Seabrook et al. used the clustered condition based on the finding from their second experiment that there were no differences between massed and highly clustered repetitions. Given that ‘clustered’ repetitions more closely resemble instruction in the classroom, the massed repetition schedule was dropped for their classroom-based experiment. Thus, students were either given lessons on reading skills (e.g., phonemic awareness) in a distributed manner of three 2-minute sessions per day, or a ‘clustered’ manner of one 6-minute session per day, for a course of two weeks. Results of experiment 3 indicated that those who were taught using the distributed sessions showed six times the improvement on reading skills as those students taught with the single sessions.

Rationale for the Present Study

The educationally relevant and classroom-based studies of the spacing effect discussed in the previous two sections are summarized in Table 2.1. Taken as a whole, there are few studies on the spacing effect using ecologically valid materials with respect to education. Moreover, even fewer studies have been conducted in actual classrooms, or with students below the undergraduate level. As others have suggested (e.g., Dempster, 1988) ecologically valid demonstrations of the spacing effect are the critical element to bridging the gap between research and educational practice. Considering the overwhelming amount of research on the spacing effect over the past 100 years, it is an injustice to the relationship between research in cognition and educational practice that there are not more intervention studies with respect to the spacing effect.

While there have been several researchers (e.g., Demspter,1988; Rohrer & Pashler, 2007), who have taken results from the spacing effect literature and outlined recommendations for teachers on how they can use these principles of learning with their students and in their classrooms, what has yet to be studied extensively is the reverse; that is, how can information regarding teaching practices with respect to repetition influence the ecological validity of research methodologies used in spacing effect studies? One possible explanation for the lack of studies conducted in the classroom may be due to the lack of research on classroom practices, particularly with regard to how teachers use repetition as a teaching strategy. With greater understanding of classroom behaviors and teaching strategies, researchers can create studies of the spacing effect that closely resemble actual practices. While there is a need for research to influence practice, there is an equivalent need for practice to influence research methodologies.

This latter statement becomes clearer by examining a specific example: consider the research finding previously discussed that indicated that a spaced homework schedule results in greater achievement than a massed (or "vertical") homework schedule. While researchers can recommend that teachers use a spaced method of homework assignment, if teachers cannot *practically* use these methods in their classrooms, the results of this study become irrelevant to classrooms. Teachers are up against time and curriculum restraints that are often barriers to the application of research findings to practice.

What is also clear is that with the exception of Rothkopf's (1963) study, none of the studies summarized here examine the spacing effect with teachers' perspectives in mind; that is, such things as teacher preferences, practicality of methods in the classroom, perceived effectiveness as a teaching strategy, or curriculum restraints. With knowledge

of what teachers report doing in their classrooms, researchers can modify their methodologies to resemble what occurs in a natural environment.

And finally, several researchers have made blanket statements that teachers are unaware of the spacing effect or that there is a failure of the educational system to apply research findings on the spacing effect (e.g., Dempster 1998), however these claims are not supported by empirical evidence. It is unclear whether teachers possess knowledge of the spacing effect, and if they do, to what extent this knowledge influences their teaching preferences and behaviors. This rationale was used as the basis for the present research. Chapter 3 presents the methodology used for the study.

Table 2.1. *Educationally Relevant and Classroom-Based Studies*

Study	Participants	Materials
Reynolds & Glaser (1964)	Junior High	Biology lessons
Fishman, Keller, Atkinson (1968)	5th graders	Computerized Spelling Drills
Reder & Anderson (1982)	Undergraduates	Textbook summaries
Smith & Rothkopf (1984)	Undergraduates	Statistics lectures
Rea & Modigliani (1985)	3rd graders	Spelling lists and multiplication facts
Dellarosa & Bourne (1985)	Undergraduates	Sentences
Dempster (1987b)	Undergraduates	Vocabulary lists
Glover & Corkill (1987)	Undergraduates	Paragraphs and brief lectures
Krug, Brandon, & Glover (1990)	Undergraduates	Paragraphs
Bahrick, Bahrick, Bahrick, & Bahrick (1993)	Adults	Foreign Language Word Pairs
Moss (1996)	2nd and 4th graders	Verbal and Mathematics Skills
Revek (1997)	Undergraduates	Pre-Calculus Homework
Childers & Tomasello (2002)	2-year-olds	Nouns & Verbs
Son (2004)	Undergraduates	GRE synonym pairs
Seabrook, Brown, and Solity (2005)	5-year-olds	Reading skills

Table 2.1. *(Continued)*

Study	Participants	Materials
Riches, Tomasello, & Conti-Ramsden (2005)	normal language children aged 3 to 4 SLI children ages 5 to 6	Verbs
Yazdani and Zebrowski (2006)	9th and 10th graders	Geometry Homework
Rohrer & Taylor (2006; 2007)	Undergraduates	Mathematics Practice Problems

CHAPTER 3

METHOD

This study utilized a survey research design with a convenience sample of teachers in the United States who taught children in early childhood through twelfth grade. After receiving approval from Temple University's Institutional Review Board, a self-report web-based survey was posted to various online forums with high teacher memberships.

Participants

The final respondent sample included 303 teachers from across the United States. Characteristics of the sample are summarized in Table 3.1. The sample included a much higher proportion of females (93%) as compared to males (7%). Respondents ranged in age from 22 to 66 years (M = 43.8, SD = 10.7). With respect to certification, ninety-six percent of the sample reported that they were certified in education, with 42% in elementary, 4% in middle, 7% in secondary, 5% in special education, 28% in a combination of levels, and 15% reporting a certification in some other area. Forty-one percent reported teaching more than one subject area, with the most frequently selected subject areas including English/language arts (43%), science (41%), and mathematics (41%). Approximately 92% reported being certified in the subject area(s) that they taught. Eight-five percent of the sample indicated teaching in public schools, and 43% indicated teaching in a suburban area. Approximately 68% of the sample taught exclusively at one grade level at the time of survey completion, and a greater percentage of the sample taught at the elementary level as compared to middle or high school level. Years of experience at each grade level ranged from a mean of 4.3 years (SD = 5.1) for

those who have taught early childhood (ages 0 – 2) to a mean of 7.4 years (*SD* = 7.4) for those who have taught ninth grade. In terms of educational level, very few teachers in the sample reported not obtaining a degree (3%), while the majority reported having obtained a master's level degree (63%). With respect to average class size, teachers in the sample reported a mean class size of 21 students (*SD* = 6.8), with a range from 2 to 40 students.

Instrumentation

Survey development overview. The development of the survey instrument for this study consisted of several steps. The first step in this process was to outline specific objectives for the survey that were consistent with the overall research goals. Second, problematic areas of a survey used in a pilot of this research were identified with the intent of revising or eliminating these problematic areas in the survey used in the current research (the pilot study and survey can be found in Appendices A and B, respectively). In addition, successful areas of the pilot study survey were also identified with the goal of retaining these areas in the instrument used for this study. Third, in accordance with the third research objective of this study, that is, of assessing teachers' beliefs about the ecological validity of massed verses spaced teaching methods, "prototypical" methodologies were selected from several applied studies of the spacing effect with the intent of using these methodologies as the basis for several scenarios in the survey on which items were based.

Table 3.1. *Respondent Sample Characteristics*

	Percent (*N*)	Mean	SD	Min	Max
Gender					
Male	6.9% (21)				
Female	93.1% (282)				
Age	--	43.8	10.7	22	66
Certification					
Elementary	41.5% (120)				
Middle	4.2% (12)				
Secondary	6.6% (19)				
Special Education	5.2% (15)				
Combination	28.0% (81)				
Other	14.5% (42)				
Subject Areas					
Computers/ Technology	14.5% (44)				
ESL	7.3% (22)				
Foreign	1.0% (3)				
Arts/English	43.2% (131)				
Mathematics	40.9% (124)				
Music	4.3% (13)				
Performing/ Visual Arts	7.9% (24)				

Table 3.1. *(Continued)*

	Percent (*N*)	Mean	SD	Min	Max
PE	4.3% (13)				
Science	41.6% (126)				
Social Science	5.9 (18)				
Social Studies/History	32.0% (97)				
Do not teach a specialized subject area	17.8% (54)				
Location					
Suburban	48.5% (143)				
Rural	28.5% (84)				
Urban	23.1% (68)				
Setting					
Public	85% (258)				
Private	4.6% (14)				
Parochial	3.3% (10)				
Charter	3.3% (10)				
Other	3.6% (11)				
Grade Levels/Years Experience					
Early Childhood Ages 0 - 2	1% (2)	4.3	5.1	1	20

Table 3.1. *(Continued)*

	Percent (*N*)	Mean	SD	Min	Max
Early Childhood Ages 3 - 5	1% (2)	4.3	5.1	1	20
Kindergarten	25.1% (76)	7.4	7.8	1	33
First grade	22.4% (68)	6.5	7.2	1	33
Second grade	21.5% (65)	5.8	6.4	1	33
Third grade	18.5% (56)	6.3	6.4	1	33
Forth grade	17.2% (52)	6.2	6.5	1	33
Fifth grade	15.2% (46)	7.1	7.6	1	33
Sixth grade	12.5% (38)	6.3	6.9	1	33
Seventh grade	13.2% (40)	7.6	7.9	1	33
Eighth grade	11.2% (34)	7.8	7.4	1	33
Ninth grade	6.9% (21)	7.0	8.1	1	35
Tenth grade	7.3% (22)	7.4	7.4	1	30
Eleventh grade	7.6% (23)	6.9	7.2	1	30
Twelfth grade	6.6% (20)	7.2	7.3	1	30
Degree					
Associates	2.3% (7)				
Bachelors	33.1% (100)				
Masters	62.6% (189)				
Doctoral	1.0% (3)				
No degree	1% (3)				

Table 3.1. *(Continued)*

	Percent (*N*)	Mean	SD	Min	Max
Class Size		20.5	6.8	2	40
Region					
Southeast	21.9% (66)				
Northeast	44.5% (134)				
Northwest	9.3% (28)				
Southwest	24.3% (73)				

Based on these first three steps in the development process, a preliminary survey was drafted and organized into three sets of items, each corresponding to one of the three overall research objectives of this study. Following this initial draft, the survey was programmed into SurveyMonkey software and then pretested on a small convenience sample of teachers and educational psychologists. Subsequently, the survey was revised incorporating feedback from the pretest phase of development. Each of these aforementioned steps is explained in more detail in the sections that follow.

Specific survey objectives. While the survey was designed to investigate the overall research objectives outlined in Chapter 1, a list of more specific objectives was created to help guide item development and organization of the survey. These specific survey objectives are outlined in Table 3.2.

Table 3.2. *Alignment of Research Objectives and Specific Survey Objectives*

Research objectives	Specific survey objectives
To investigate teachers' self-reported use and opinion of repetition as a teaching strategy	Do teachers self-report that they use repetition in the classroom? If teachers report using repetition: • What kinds of information do they report using in a repetitive manner? • Do teachers report that the second presentation (i.e., the repetition) of information is likely to be verbatim or paraphrased? • Why do teachers report using repetition as a teaching strategy? • How do teachers report using repetition as a teaching strategy? What are teachers' beliefs about using repetition as a teaching strategy? • Do teachers believe it is an effective and practical teaching strategy? • Do teachers believe it is enjoyable for students? If teachers do not report using repetition, what are the reasons they do not use it?
To investigate teachers' self-reported preferences and beliefs about massed versus distributed teaching strategies	If given a choice between the two teaching strategies, which do teachers report preferring? What are teachers' beliefs regarding massed versus distributed teaching strategies? • Do teachers believe that one strategy is more effective, more practice, and more enjoyable for students over the other?

Table 3.2. *(Continued)*

Research objectives	Specific survey objectives
To investigate teachers' self-reported beliefs regarding the ecological validity of massed versus distributed teaching methods	Do teachers report that either the massed or distributed methods used in applied spacing effect studies more closely resemble learning/teaching as it would occur in an actual classroom environment?

Improvements from the pilot study survey. One of the goals in revising the pilot study survey was to improve upon the wording of items. For instance, several items were found to be "double-barreled" (e.g., students learn more *effectively* and *efficiently* in smaller distributed blocks of time as opposed to larger blocks of time). Additionally, some of the items in the survey needed a clearer reference point for comparison. Since this study compared distributed repetition and massed repetition, the revised items specifically contrasted the two, unlike the items in the pilot study survey. For example, item 10 on the pilot study survey (i.e., "teaching a lesson and then returning to the same lesson several days later is beneficial to my students' learning") would have been a better item had it been written as: "Teaching a lesson and then returning to the same lesson several days later is more beneficial to my students' learning than not returning to the lesson days later". In addition, the survey used in the pilot study did not operationally define important terms. Teachers completing the survey may have interpreted the term "repetition" differently. As a consequence, operational definitions of important terms

were included in the survey for the current research. Finally, the term “review” used in the pilot study survey was eliminated from instrument used in the current research for parsimony.

Successful areas of the pilot study survey. The strongest area of the pilot study survey was a section that included several “scenarios” (for details of this methodology see Appendix A). In this section of the survey, respondents read two brief descriptions that depicted teachers using various teaching methods. In one of the descriptions the teacher utilized either repetition or a spaced instructional strategy, and in the other description the teacher utilized either no repetition or a massed instructional strategy. Each scenario in the survey was modeled after actual research methodologies used in studies of the spacing effect. The use of descriptive scenarios, followed by a set of questions referring to them was retained in the instrument used for the current research.

Prototypical methodologies. The survey instrument for the current research incorporates examples from the literature (designed into scenarios) in order to investigate the third research objective, that is, to investigate teachers’ self-reported beliefs regarding the ecological validity of massed versus distributed teaching methods. The studies identified as “prototypical” are shown in Table 3.3. Scenario text which corresponds to the massed and spaced conditions used in each experiment is shown. The details of these experiments are summarized in Chapter 2 as well as in Table 2.1.

Table 3.3. *Scenarios in the Survey Instrument and Corresponding Experiments*

Scenarios	Experiment
	Scenario 1: Smith & Rothkopf (1984)
Massed	You enroll in an 8-hour mini-course on introductory statistics. This course is completed within this one day; that is, it begins at 9:00 a.m. and is finished at 5:00 p.m.
Distributed	You enroll in an 8-hour mini-course on introductory statistics. This course is completed in four days, with each day consisting of a 2-hour session; that is, it begins at 9:00 a.m. and is finished at 11:00 a.m. each day for four successive days.
	Scenario 2: Seabrook et al. (2005)
Massed	Mr. Smith is an elementary school teacher who is teaching a lesson on reading skills. The goal of the lesson is to help students learn new sight words, and increase blending and segmentation of sounds. Over the course of two weeks, he teaches reading skills daily in one 6-minute mini-lesson that occurs mid-day.
Distributed	Mr. Smith is an elementary school teacher who is teaching a lesson on reading skills. The goal of the lesson is to help students learn new sight words, and increase blending and segmentation of sounds. Over the course of two weeks, he teaches reading skills daily in three 2-minute mini-lessons with the following schedule: one in the morning, one mid-day, and one just before school ends for the day.
	Scenario 3: Dempster (1987b)
Massed	Mrs. Doe is a middle school teacher who is teaching her students a new study strategy for learning vocabulary words. Each student receives a booklet with 114 pages. On each page is a vocabulary word with its definition. The vocabulary words are repeated 3 times each within the booklet, one right after another. Students are instructed to study each page for 7 seconds.

Table 3.3. *(Continued)*

Scenarios	Experiment
Distributed	Mrs. Doe is a middle school teacher who is teaching her students a new study strategy for learning vocabulary words. Each student receives a booklet with 114 pages. On each page is a vocabulary word with its definition. The vocabulary words are repeated 3 times each within the booklet, with 37 pages between each repetition. Students are instructed to study each page for 7 seconds.
	Scenario 4: Childers and Tomasello (2002)
Massed	Miss Linda is a teacher in a daycare center who works with 2-year old children. As an early childhood teacher one of her primary responsibilities is to teach her students novel words (e.g., nouns and verbs) through individual play sessions. She exposes a new word in 4 play sessions on a single day.
Distributed	Miss Linda is a teacher in a daycare center who works with 2-year old children. As an early childhood teacher one of her primary responsibilities is to teach her students novel words (e.g., nouns and verbs) through individual play sessions. She exposes a new word in 4 play sessions, each on a different day.
	Scenario 5: Krug et al. (1990)
Massed	Mr. Chan is a high school English teacher. He would like his students to remember main ideas from a 600 word essay. He asks his students to read the essay and afterwards to re-read the essay immediately.
Distributed	Mr. Chan is a high school English teacher. He would like his students to remember main ideas from a 600 word essay. He asks his students to read the essay, and then to re-read the essay one week later.

Table 3.3. *(Continued)*

Scenarios	Experiment
	Scenario 6: Yazdani and Zebrowski (2006)
Massed	Ms. Baker is a high school mathematics teacher. On any given day she assigns homework that corresponds to the topic that she taught in class that day.
Distributed	Ms. Baker is a high school mathematics teacher. On any given day she assigns homework that corresponds to the topic that she taught in class that day, along with reinforcement of topics that were covered previously.

Pretesting and revisions. A preliminary survey instrument was drafted based on the process described in the previous sections, programmed into SurveyMonkey software (which creates a web-based version of the survey), and subsequently pretested on a small convenience sample of teachers and educational psychologists. Participants in the pretest phase were asked to critique the instrument and provide comments and/or suggestions on content and formatting. Suggestions from the pretest phase, in general, surrounded the formatting (e.g., alphabetizing items with a list) and wording of items. Several items on a preliminary version of the survey that dealt with teachers' estimates of the frequency of certain behaviors were eliminated in the final version of the survey.

Instrument

The final version of the self-report web-based survey instrument for the current research is contained in Appendix C. The survey formatting was slightly modified from its web-based version for purposes of presentation in this paper. In total, the survey

contained 60 items, several of which had multiple components. The first section of the survey contained 15 multiple choice and open-ended numeric questions that were created for the purpose of collecting demographic information on respondents. The bulk of the items in the survey addressed the research objectives of the study. Question formats included multiple choice, open-ended responses, and 5-point Likert Scales. The table of specifications for the survey instrument is included in Table 3.6.

Procedure

The survey was administered between January 15th, 2009 and February 20th, 2009. Respondents to the survey were recruited from online forums that contained a large number of teachers. To obtain permission to post the survey to each of the forums, an initial email was sent to each forum manager asking them for permission to join the forum. Once permission was granted, a message was posted to each discussion board, along with a brief introduction explaining the researcher's background, an overview of the survey, and a hyperlink to the survey. In the majority of the forums, the posted message was first approved by the forum manager. In a few of the forums, permission to post a discussion topic was not required from the manager. If a potential respondent was interested in participating in the survey, clicking on the link in the posted message would direct the potential respondent to a cover letter explaining the purpose of the study, and the voluntary and confidential nature of the study. A potential respondent could decline consent to participate in the survey by exiting the survey browser. In total, data were gathered from 41 online forums. Table 3.4 provides a summary of the types of online forums to which the survey was posted, and an example of each.

Table 3.4. *Online Forums for Data Collection*

Type (*N*)		Example
Grade specific groups (13)	Group Name	4thgradeteachers
	Website	http://dir.groups.yahoo.com/group/4thgradeteachers/
	Description	This is a list for all fourth grade teachers. Together lets share ideas, frustrations, lesson plans, and make some friends.
Content-area specific groups (10)	Group Name	Math-Learn
	Website	http://groups.yahoo.com/group/math-learn/
	Description	This focus of this group is courteous discussion about the teaching of mathematics.
Multi-grade level groups (4)	Group Name	Teaching is a work of the heart
	Website	http://dir.groups.yahoo.com/group/teachingisaworkofheart/
	Description	Welcome! A list of k-4 teachers sharing ideas, tips, lessons, links and much more. If you are a teacher, student teacher, or a person who loves teaching children this is the ring for you to join. You will learn so much from so many. So much of what we do at the different grade levels can be shared and modified to meet the needs of all grade levels.

Table 3.4. *(Continued)*

Type (*N*)		Example
Support groups (12)		
	Group Name	Fact World
	Website	http://dir.groups.yahoo.com/group/factworld/
	Description	The Forum for Across the Curriculum Teaching is a network of teachers interested in cross-curricular issues and working to develop and support the teaching of content and language integrated subjects
Other groups (2)		
	Group Name	Small Schools
	Website	http://dir.groups.yahoo.com/group/smallschools/
	Description	Small schools and "Learning Communities" are an innovative way teach and learn in a safer, more intimate and equitable learning environment where teaching can become more closely connected with the lives of kids.

Analysis

Data cleaning and recoding. Survey responses were downloaded in Excel format from SurveyMonkey and then imported into SPSS version 17 for data cleaning and statistical analysis. A data cleaning processes was conducted to ensure validity of survey responses, and to exclude from the respondent sample any survey with a high percentage of unanswered items, or any respondent who had indicated that they were not currently a teacher in item 3. Due to the web-based nature of this survey, it was of concern that one

individual might complete the survey more than once. Therefore, a frequency was run on IP address (a variable captured by SurveyMonkey) and respondents with duplicate IP addresses were flagged for further investigation. None of the respondents with duplicate IP addresses, however, were found to be invalid and therefore were not eliminated from the final sample.

Following the data cleaning process, several items were recoded to aid interpretation of results and to perform statistical analyses. For example, in order to compare mean scores on items for different demographic groups via Analysis of Variance, responses to several of the demographic items were recoded to aid in analysis. The original variable and the new variable categories are summarized in Table 3.5. Response options to item 18 were recoded into dichotomous variables in order for Chi-square analyses to be conducted between each response option and each demographic variable listed in Table 3.5. Thus, for example, the first response option of “Concepts build on one another” was recoded such that a ‘1’ indicated that the respondent selected this response option and ‘0’ indicated that the respondent did not select this response option. A chi-square test for independence was then conducted to determine whether there was a significant association between each of the demographic variables listed in Table 3.5 and those who selected this response option. On item 21 of the survey instrument, the “not applicable” response option was coded to a value of ‘3’ by SurveyMonkey and recoded to a missing value with SPSS so that it was not included in the valid percentages on frequency tables.

Table 3.5. *Recoding of Demographic Variables Used in Statistical Analyses*

Item	Original Variable Description	New Variable Categories	Percent	*N*
In which US state do you currently teach?	Categorical (select one option): All states listed	Northeast	45.0%	134
		Northwest	9.1%	27
		Southeast	21.8%	65
		Southwest	24.2%	72
What grade level(s) do you currently teach?	Categorical (select all that apply): Early childhood (0-2) through Grade 12	Early childhood exclusively	27.0%	69
		Elementary grades exclusively	34.0%	102
		Middle and/or high school grades exclusively	28.7%	86
What is your age?	Continuous (open-ended numerical)	20 – 35	30.1%	90
		36 – 50	38.1%	114
		Older than 50	37.1%	95
On average, how many students are in your class(es)?	Continuous (open-ended numerical)	20 students or less	51.4%	150
		More than 20 students	48.6%	146

Note. Missing data are excluded from percentages

Finally, several of the items with response options on a Likert Scale were reverse coded before being entered into factor analyses (i.e., principal component analyses with varimax rotation). Items 29d, 29f, 29g, 29h, 29i were recoded (i.e., 1 = 5, 2 = 4, 3 = 3, 4 =

2, 5 = 1) such that higher values on these items could be interpreted to mean a higher favorability of distributed instruction as teaching strategy.

Analysis overview. Table 3.6 presents each research objective, the corresponding items on the survey that address these objectives, the nature of the data, and the analyses that were conducted to investigate each research objective. Details and results of these analyses are presented in Chapter 4.

Table 3.6 *Table of Specifications and Planned Statistical Analyses*

Research Objective	Survey Items	Data	Planned Analyses
1a) Self-reported Use of repetition	16 – 21; 23 – 28	Categorical: 16 – 21; 24, 27, 28	Overall frequency tables for all items Chi-square Analyses to examine the association with demographic variables (Item 18)
1b) Beliefs about repetition	22a – 22j	Continuous: all items (1 = strongly disagree to 5 = strongly agree)	Overall frequency tables for all items and descriptive statistics Principle Components Analysis with Varimax rotation to reduce data into factor(s) One-way ANOVAs with demographic groups as independent variable and factor(s) as dependent variable
2a) Self-reported preferences regarding massed versus distributed teaching methods	30a – 30c 30e – 30g	Continuous: all items (1 = strongly disagree to 5 = strongly agree)	Overall frequency tables for all items and descriptive statistics
	35, 40, 45, 50, 55, 60	Categorical	Overall frequency tables

Table 3.6 *(Continued)*

Research Objective	Survey Items	Data	Planned Analyses
2b) Beliefs about massed versus distributed teaching methods	29a – 29j 30d	Continuous: all items (1 = strongly disagree to 5 = strongly agree) Items 29d, 29f, 29g, 29h, 29i reversed coded prior to factor analysis	Overall frequency tables for all items and descriptive statistics Principle Components Analysis with Varimax rotation to reduce data into factor(s) One-way ANOVAs with demographic groups as independent variable and factor(s) as dependent variable
	31, 33, 34 36, 38, 39 41, 43, 44 46, 48, 49 51, 53, 54	Categorical: all items except 43 & 44 Continuous: items 43, 44 (1 to 10 scale)	Overall frequency tables Means for items 43 & 44
3) Beliefs about the ecological validity of massed versus distributed teaching methods	32, 37, 42, 47, 52, 57	Categorical	Overall frequency tables

CHAPTER 4

RESULTS

The primary purpose of this study was to investigate the spacing effect from a teachers' perspective using a self-reported survey of teaching strategies. More specifically, the following research objectives of this study were to investigate teachers' self-reported:

1) use and opinion of repetition as a teaching strategy

2) preferences and beliefs regarding massed versus distributed teaching strategies

3) beliefs regarding the ecological validity of massed versus distributed teaching methods

These research objectives will be divided into smaller components in this section for ease of presentation and interpretation.

Objective 1a: Self-Reported Use of Repetition

Frequency Distributions

To address the first research objective on self-reported use of repetition, frequency tables were first produced for items 16 to 21, item 24, and items 27 to 28. Remarkably, nearly all of the teachers in the sample (99.0%) reported using repetition to enhance their students' learning. Of the three teachers who reported not using repetition as a teaching strategy, two of the three (or 66.7%) reported that "using repetition is too time consuming" and one of the three teachers (or 33.3%) reported that "my students get bored with repetition." Of the 300 teachers who indicated that they used repetition to enhance their students' learning, 90.7% indicated that they used repetition to reinforce important concepts, 84.0% reported using repetition because it aided student learning,

81.0% reported that repetition reinforced difficult to understand concepts, 79.7% indicated that they used repetition because concepts build on one another, 63.7% reported using repetition because it helps to establish a routine, and 60.7% reported using repetition because it is helpful with memorization; only 30.7% of the teachers in the sample reported using repetition because their students enjoy it, and 29.7% indicated that repetition is part of their curriculum. When asked to indicate the primary reason why repetition was used, the most selected option was “to reinforce important concepts” (31.4%), followed by “it helps my students to learn” (29.4%). Very few teachers indicated that the primary reason repetition was used as a teaching strategy was because it is part of their curriculum (1.3%) or because their students enjoy it (1.0%). Results are shown in Table 4.1.

With respect to the nature of the second presentation of to-be-learned information, the overwhelming majority (88%) of the teachers in the sample reported that the second presentation (the repetition) is paraphrased. About 5% of the teachers reported that the repetition is verbatim, while slightly more (7%) indicated that the repetition does not, in general, resemble the original presentation of the information at all.

In response to “Please indicate whether or not you use each of the following in a repetitive manner with the intent of enhancing your students’ learning”, over 90% of the teachers in the sample reported using difficult concepts (97.0%), in-class practice (94.5%), facts (92.2%), and portions of a lesson (92.3%) in a repetitive manner. Only 29.1% indicted that they would repeat an entire lesson as a teaching strategy to enhance learning. A complete frequency distribution for this item are shown in Table 4.2.

Table 4.1. *Count and Percentage of Teachers' Reported Reasons for Using Repetition*

	Select all that Apply		Select the Main Reason	
Reasons	*N*	Percent	*N*	Percent
To reinforce important concepts	272	90.7%	94	31.4%
It helps my students to learn	252	84.0%	88	29.4%
To reinforce difficult to understand concepts	243	81.0%	33	11.0%
Concepts build on one another	239	79.7%	42	14.0%
It establishes a routine	191	63.7%	18	6.0%
It helps with memorization of facts and ideas	182	60.7%	9	3.0%
My students enjoy it	92	30.7%	2	1.0%
It is part of my curriculum	89	29.7%	4	1.3%
Other	29	9.6%	9	3.0%

Note. The base for this item are those who reported using repetition (*N* = 300)

Table 4.2. *Count and Percentage of Classroom Items Reported to be used in a Repetitive Manner*

	Response: Yes	
	N	Percent
Difficult Concepts	284	97.3%
In-class Practice	277	94.5%
Portions of a lesson	265	92.3%
Facts	249	92.2%
Disciplinary Commands	253	88.2%
Classroom Discussions	216	77.4%
Hands-on Activities	217	76.1%
Reading Assignments	170	72.0%
Homework Assignments	156	65.5%
Easy Concepts	167	57.4%
Exams/tests/quizzes	129	54.7%
Projects	105	43.4%
Entire Lessons	84	29.1%

Note. Calculated percentage does not include those who selected N/A for not applicable or those who did not respond to the question.

With respect to the most recent lesson taught, results of the frequency distributions produced on items 24, 27, and 28 indicated that the overwhelming majority of the sample (95.3%) reported that they used repetition within their most recent lesson. Only a slightly smaller proportion of the sample (87.8%) indicated that they planned on repeating the lesson, or a portion of it, in the future. In response to the timing of when the repetition would occur, 39.3% reported they would repeat the lesson or a portion of it in the same week as the original presentation, 24.8% indicated that the repetition would occur in the following week, 18.7% reported that the repetition would occur at some "other" time not listed as a response option, 6.5% were uncertain as to when the repetition would occur, 5.7% reported that it would occur within the same month as the original presentation of the information, and 5.0% thought that the repetition would occur in more than a month's time from the original presentation.

Chi-Square Tests for Independence

In addition to frequency distributions to investigate teachers' self-reported use of repetition as a teaching strategy, chi-square tests for independence were conducted on item 18 (i.e., "reasons why you may use repetition in your classroom") to determine which, if any, of the following demographic variables were associated with each response option: region (Northeast vs. Northwest vs. Southeast vs. Southwest), grade group (early childhood vs. elementary vs. middle/high school), class size group (20 students or less vs. more than 20 students), and teacher age group (20 to 35 vs. 36 to 50 vs. older than 50). Results are summarized in Table 4.3.

Table 4.3. *Chi-square Tests for Independence by Item Option and Demographic Group*

Response Options	Region			Grade Group			Age Group			Class Size		
	χ^2	*p*	Cramer's *V*	χ^2	*p*	Cramer's *V*	χ^2	*p*	Cramer's *V*	χ^2	*p*	Phi
Concepts build on one another	4.24	0.24	0.12	1.75	0.41	0.08	0.30	0.86	0.03	0.00	0.95	0.00
It establishes a routine	2.98	0.40	0.10	***22.06***	***0.00***	***0.29***	1.64	0.44	0.07	1.76	0.19	0.08
It helps my students to learn	0.56	0.91	0.04	0.68	0.71	0.05	0.18	0.91	0.02	0.04	0.84	0.01
It helps with memorization of facts and ideas	1.37	0.71	0.07	4.37	0.11	0.13	2.92	0.23	0.10	2.39	0.12	0.09
It is part of my curriculum	**9.51**	**0.02**	**0.18**	***11.46***	***0.00***	***0.21***	1.22	0.54	0.06	0.10	0.76	0.02
My students enjoy it	5.59	0.13	0.14	***17.85***	***0.00***	***0.26***	4.90	0.09	0.13	0.10	0.75	0.02
To reinforce important concepts	3.99	0.26	0.12	**7.64**	**0.02**	**0.17**	1.55	0.46	0.07	0.21	0.65	0.03

Table 4.3. *(Continued)*

Response Options	Region			Grade Group			Age Group			Class Size		
	χ^2	*p*	Cramer's *V*	χ^2	*p*	Cramer's *V*	χ^2	*p*	Cramer's *V*	χ^2	*p*	Phi
To reinforce difficult to understand concepts	2.29	0.51	0.09	4.93	0.09	0.14	1.54	0.46	0.07	0.68	0.41	0.05

Note. Bolded numbers are significant at the $p < .05$ level; those in bold and italics are significant at the $p < .01$ level.

The demographic variables of age group and class size were not significantly associated with any of the response options on item 18; however, grade group was significantly associated with half of the response options for this item. For example, grade group was significantly associated with "it establishes a routine" χ^2 (2, n = 257) = 22.06, p = .000, such that 88% of those who taught early childhood selected this option while 62.7% of elementary and 53.4% of those who taught middle/high school selected this option. The strength of the association between grade group and this response option was found to be medium according to standards outlined by Cohen (1988) (Cramer's V = .29). The 2 (selected vs. did not select) x 3 (early childhood vs. elementary vs. middle/high school) contingency table is presented in Table 4.4.

Table 4.4. *Contingency Table of Grade Group x Routine*

		Routine		
	Grade group	Did not select	Selected	Total
	Early Childhood	8 (11.5%)	61 (88.4%)	69
	Elementary	38 (37.2%)	64 (62.7%)	102
	Middle/High school	40 (46.5%)	46 (53.4%)	86
Total		86	171	257

Grade group was significantly associated with "my students enjoy it" such that early childhood teachers were more likely to select this option than elementary and

middle/high school teachers χ^2 (2, n = 257) = 17.85, p = .000. Cramer's V (.26) indicated that the strength of the association between the variables was medium. The contingency table for this analysis is shown in Table 4.5.

Table 4.5. *Contingency Table of Grade Group x Enjoy*

		Enjoy		
	Grade group	Did not select	Selected	Total
	Early Childhood	34 (49.2%)	35 (50.7%)	69
	Elementary	68 (66.6%)	34 (33.3%)	102
	Middle/High school	70 (81.3%)	16 (18.6%)	86
Total		172	85	257

Grade group was also significantly associated with "it is part of my curriculum" such that early childhood teachers were more likely to select this reason than were elementary and middle/high school teachers, χ^2 (2, n = 257) = 11.46, p = .003. The strength of the association between the variables was medium (Cramer's V = .21). Table 4.6 presents the 2 (selected vs. did not select) x 3 (early childhood vs. elementary vs. middle/high school) contingency table for "it is part of my curriculum."

Table 4.6. *Contingency Table of Grade Group x Curriculum*

		Curriculum		
	Grade group	Did not select	Selected	Total
	Early Childhood	37 (53.6%)	32 (46.3%)	69
	Elementary	74 (72.5%)	28 (27.4%)	102
	Middle/High school	67 (77.9%)	19 (22.0%)	86
Total		178	79	257

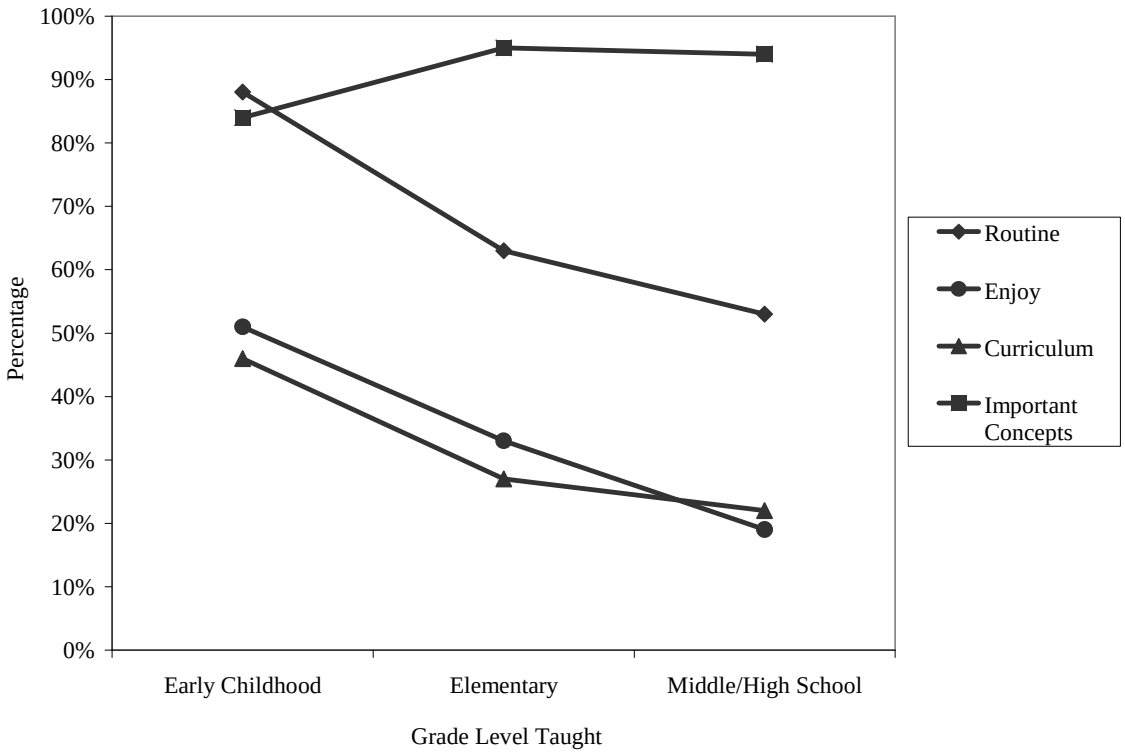
Finally, grade group was significantly associated with "to reinforce important concepts" χ^2 (2, n = 257) = 7.643, p = .022, however the strength of the association was small (Cramer's V = .17). As shown in Table 4.7, elementary and middle/high school teachers were more likely to select this option than early childhood teachers in the sample.

Table 4.7. *Contingency Table of Grade Group x Important Concepts*

		Important Concepts		
	Grade group	Did not select	Selected	Total
	Early Childhood	11 (15.9%)	58 (84.0%)	69
	Elementary	5 (4.9%)	97 (95.1%)	102
	Middle/High school	5 (5.8%)	81 (94.1%)	86
Total		21	236	257

Figure 4.1 presents a graphic illustration of the significant chi-square results for grade level taught.

Figure 4.1. Percentage of Teachers Reporting Reasons for using Repetition by Grade Level Taught



Region was significantly associated with the response option "it is part of my curriculum," χ^2 (3, n = 298) = 9.51, p = .023. The 2 (selected vs. did not select) x 4 (southeast vs. northeast vs. southwest vs. northwest) contingency table in Table 4.8 reveals that teachers in the Northwest were more likely to report "it is part of my curriculum" as a reason why repetition is used than teachers in the Northeast, Southeast, and Southwest. Cramer's V (.18) indicated that the strength of the association between the variables was medium.

Table 4.8. *Contingency Table of Region x Curriculum*

	Curriculum		
Region	Did not select	Selected	Total
Southeast	55 (84.6%)	10 (15.4%)	65
Northeast	92 (68.7%)	42 (31.3%)	134
Southwest	46 (63.8%)	26 (36.1%)	72
Northwest	16 (59.2%)	11 (40.7%)	27
Total	209	89	298

Objective 1b: Self-Reported Beliefs about Repetition as a Teaching Strategy

Frequency Distributions

To investigate teachers' beliefs about repetition as a teaching strategy, frequencies were produced for each sub-item contained within item 22 ("Please rate the extent to which you agree or disagree with each item"), and are presented in Table 4.9. Results of the frequencies calculated on the sub-items contained in item 22 revealed that teachers held strong positive beliefs about repetition as a teaching strategy. The large majority (92.0%) of the respondent sample of teachers either somewhat or strongly agreed that repetition is an effective teaching strategy, however, a smaller proportion of teachers (57.5%) either somewhat or strongly agreed that repetition is the most important teaching strategy. While the overwhelming majority of the teachers felt that repetition is a strategy

that can be used on a daily basis (41.9% somewhat agreed, and 38.9% strongly agreed), teachers expressed that time limitations can prevent them from using repetition to a greater extent (31.2% somewhat agreed, and 15.1% strongly agreed). About 53.5% of the teacher sample either somewhat or strongly agreed that "enough" time was available to use repetition effectively. With respect to students and use of repetition, teachers again expressed strong beliefs. In particular, roughly 71.0% of the sample either somewhat or strongly agreed that repetition is more beneficial to struggling students than other students. About 63.1% of the respondents expressed that students enjoy when repetition is used, and 73.5% believed that students are attentive during the second presentation of information (the repetition). With respect to grade level and subject area, an overwhelming 90.3% of the sample agreed (either somewhat or strongly) that repetition is an effective teaching strategy for their grade level, and 70.0% agreed (either somewhat or strongly) that using repetition is beneficial to learning regardless of the subject area.

Descriptive Statistics

In addition to frequency distributions, descriptive statistics such as mean, standard deviation, variance, skewness and kurtosis were calculated on each sub-item. Table 4.10 presents descriptive statistics for each sub-item contained in item 22. The skewness statistics indicated that all sub-items are negatively skewed with "a", "b", and "h" having the most negatively skewed distributions (-2.12, -1.22, and -1.77, respectively). All means for each sub-item were above 3.00 (which corresponded to "neutral" on a 5-point Likert Scale ranging from 0, strongly disagree to 5, strongly agree), and means for sub-items "a", "b", and "h" were above a 4.00 indicating that teachers held strong beliefs for these sub-items. A range of 4.00 for each sub-item indicates that the responses ranged

from the most positive response option (strongly agree) to the most negative response option (strongly disagree). Sub-item “i” had the most variability (*SD* = 1.24), while sub-item “j” had the least (*SD* = .80).

Table 4.9. *Frequency of Responses for Items 22a – 22j*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
a). In general, repetition is an effective teaching strategy.	11	3.7%	4	1.3%	9	3.0%	114	38.0%	161	53.8%
b). Using repetition on a daily basis is a practical teaching strategy.	9	3.0%	26	8.7%	22	7.4%	125	41.9%	116	38.9%
c). My students enjoy when I use repetition in my classroom.	5	1.7%	17	5.7%	88	29.5%	124	41.6%	64	21.5%
d). The benefit of repetition to learning is greater to students who are struggling than to those who are not.	11	3.7%	42	14.1%	33	11.1%	111	37.0%	101	33.7%
e). Repetition is one of the most important teaching strategies.	14	4.7%	51	17.1%	62	20.7%	122	40.8%	50	16.7%
f). In general, I have enough time available to use repetition in my classroom as an effective teaching strategy.	23	7.7%	65	21.7%	51	17.1%	116	38.7%	44	14.7%
g). Repetition of lessons is beneficial to learning regardless of the subject area.	6	2.0%	42	14.0%	42	14.0%	125	41.7%	85	28.3%

Table 4.9. *(Continued)*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
h). Repetition is an effective teaching strategy for the grade level that I teach.	6	2.0%	9	3.0%	14	4.7%	118	39.5%	152	50.8%
i). Time limitations prevent me from using repetition more in my classroom.	29	9.7%	77	25.8%	54	18.1%	93	31.2%	45	15.1%
j). Students are attentive during the second presentation (repetition) of information.	2	1.0%	15	5.0%	62	20.8%	164	55.0%	55	18.5%

Table 4.10. *Descriptive Statistics for Items 22a – 22j*

Sub-item	*N*	Range	Mean	SD	Variance	Skewness	Kurtosis
22a	299	1 - 5	4.37	.90	.82	-2.12	5.19
22b	298	1 - 5	4.05	1.04	1.09	-1.22	.94
22c	298	1 - 5	3.76	.91	.83	-.49	.12
22d	298	1 - 5	3.84	1.15	1.32	-.82	-.30
22e	299	1 - 5	3.48	1.10	1.21	-.49	-.57
22f	299	1 - 5	3.31	1.19	1.41	-.37	-.91
22g	300	1 - 5	3.80	1.06	1.13	-.71	-.33
22h	299	1 - 5	4.34	.86	.74	-1.77	3.77
22i	298	1 - 5	3.16	1.24	1.54	-.14	-1.11
22j	298	1 - 5	3.86	.80	.64	-.66	.70

Note. For complete item and sub-item text refer, to Appendix C.

Factor Analysis

In addition to frequencies and descriptive statistics for each sub-item, exploratory factor analyses, specifically principle components analyses, were conducted to determine whether some or all of the sub-items within item 22 could be combined in some way to represent an underlying latent structure. Since the primary purpose of these analyses was to find the most appropriate solution to reduce the data, and assumptions regarding the structure of the data were not made *a priori*, exploratory analyses were considered to be most appropriate. Thus, two principle components analyses were initially conducted, one

specifying the extraction of two factors (with Varimax Rotation) and the other specifying the extraction of one factor. Solutions were compared and the best solution to represent the data was the one-factor solution that eliminated sub-items “d”, “f”, and “i”.

Screening of the data indicated that this type of analysis was appropriate. For instance, the correlation matrix (shown in Table 4.11) revealed that singularity was not an issue (no significance values were greater than .05, and no correlations were greater than .90). The determinant of the correlation matrix (.037) also indicated that multicolinearity was not present. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO statistic) was approximately .88 (or “great” according to Kaiser 1974 recommendations) indicating that factor analysis was appropriate, and Bartlett’s Test of Sphericity was also highly significant ($p < .001$) indicating that the *R*-matrix is not an identity matrix.

Kaiser’s criterion for extracting eigenvalues over one was not met (i.e., the average communality was not greater than .60 with a sample larger than 250), however, the scree plot indicated that a one factor solution would best represent the structure of the items. Using the criterion of .40 or higher, all seven items loaded onto this one factor, which accounted for approximately 58% of the variance. Table 4.12 presents the factor loadings. Cronbach’s alpha was .88, which indicated that this scale was reliable.

Table 4.11. *Correlation Matrix for Selected Sub-Items on Item 22*

	22a	22b	22c	22e	22g	22h	22j
22a	1.00	.75	.52	.47	.43	.69	.49
22b	.75	1.00	.57	.50	.45	.65	.50
22c	.52	.57	1.00	.43	.31	.45	.48
22e	.47	.50	.43	1.00	.52	.48	.38
22g	.43	.45	.31	.52	1.00	.52	.36
22h	.69	.65	.45	.48	.52	1.00	.56
22j	.49	.50	.48	.38	.36	.56	1.00
22a		.00	.00	.00	.00	.00	.00
22b	.00		.00	.00	.00	.00	.00
22c	.00	.00		.00	.00	.00	.00
22e	.00	.00	.00		.00	.00	.00
22g	.00	.00	.00	.00		.00	.00
22h	.00	.00	.00	.00	.00		.00
22j	.00	.00	.00	.00	.00	.00	

Note. Determinant = .037.

Table 4.12. *Factor Loadings for Selected Sub-Items on Item 22*

	"Favorability toward repetition"
Using repetition on a daily basis is a practical teaching strategy.	.848
In general repetition is an effective teaching strategy.	.835
Repetition is an effective teaching strategy for the grade level that I teach.	.828
Students are attentive during the second presentation (repetition) of information.	.705
My students enjoy when I use repetition in my classroom.	.705
Repetition is one of the most important teaching strategies.	.703
Repetition of lessons is beneficial to learning regardless of the subject area.	.664

Analysis of Variance

Based on the results of the principle component analysis, sub-items "a", "b", "c", "e", "g", "h", and "j" were subsequently combined into one score that represented teachers' perception of repetition as a teaching strategy, with higher scores indicating a more favorable perception. Mean scores on this "favorability toward repetition" factor were then compared to determine whether there were differences among demographic variables and beliefs about repetition. Specifically, two separate one-way ANOVAs were

conducted with grade group (early childhood vs. elementary vs. middle/high school) and age group (20 to 35 vs. 36 to 50 vs. older than 50) as the independent variables and favorability toward repetition score as the dependent variable. An independent sample *t*-test was used to determine whether there was a significant difference between class size (20 or less students vs. more than 20 students) on favorability toward repetition scores.

The first one-way ANOVA compared mean favorability toward repetition scores of each grade group. The homogeneity of variance assumption was assessed using the Levene statistic (LS). The result indicated that the homogeneity of variance assumption was not violated LS (2,250) = .77, p = .46. The analysis of variance revealed a highly significant difference between groups, $F(2,250) = 11.83$, p = .000, n^2 = .09. Post hoc analyses were conducted with a Scheffe test and revealed that those who taught early childhood (M = 30.12, SD = 4.81) had significantly higher favorability toward repetition as compared to elementary (M = 27.26, SD = 5.21) and middle/high school (M = 26.38, SD = 4.48) teachers in the sample. Eta-squared suggested a small effect size, with 9% of the variance in favorability toward repetition score accounted for by grade group. Table 4.13 shows mean favorability toward repetition score by grade group.

Table 4.13. *Mean Favorability Toward Repetition Score by Grade Group*

Grade Group	Mean	*N*	SD	Skewness	Kurtosis
Early childhood	30.12	67	4.81	-1.90	5.07
Elementary	27.26	101	5.21	-1.36	2.65
Middle/high school	26.38	85	4.48	-1.01	3.23
Total	27.72	253	5.07	-1.18	2.39

Neither the one-way ANOVA on age group, nor the independent sample *t*-test on class size group revealed significant differences.

Objective 2a: Self-Reported Preferences Regarding Massed versus Spaced Methods of Teaching

Frequency Distributions

To investigate whether teachers in the sample showed preference for either massed or spaced teaching methods, frequencies of responses were calculated for items 30a to 30c and 30e to 30g ("Please rate the extent to which you agree or disagree with each statement"). Frequencies are shown in Table 4.14. In general, the respondent sample showed preference for distributed over massed teaching methods. For example, only 21.5% of the sample either somewhat or strongly agreed that they preferred to teach an entire lesson in one day rather than distributing it over several days, and an

overwhelming 84.7% indicated that in fact they tended to distribute repetitions over several days. While teachers in the sample did report that they liked the repetition of information to occur close in time to the original presentation (68.7%), only 13.4% indicated that they tended to repeat a topic several times in a row and rarely return to it at a later time. Approximately 59.1% of the respondent sample preferred to assign homework that directly corresponded to the lesson taught that same day.

As shown in Table 4.21, strong preferences for distributed over massed teaching methods were reported in items 35, 45, and 60 (89.0%, 76.1%, and 92.4%, respectively), however, only a slightly higher proportion of teachers preferred distributed over massed teaching methods with respect to items 40 (54.7%), 50 (58.4%), and 55 (54.2%). These items on the survey were based on descriptive scenarios developed around several methodologies used in spacing effect studies (for a complete description of the scenarios and corresponding experiments, please refer to Table 3.3).

Descriptive Statistics

In addition to frequency distributions, mean, standard deviation, variance, skewness and kurtosis were calculated on items 30a to 30c and 30e to 30g and are presented in Table 4.15. All of the sub-items with the exception of “f” on item 30 can be interpreted such that higher scores on each indicate a greater preference for massed as opposed to distributed teaching methods. For item “f”, higher scores indicated a greater preference for distributed as opposed to massed teaching methods. The skewness of the frequency distributions indicated that sub-items “a”, “e”, and “f” are negatively skewed, suggesting that teachers generally agreed with these statements. On the contrary, sub-items “a”, “b”, and “g” were positively skewed indicating that teachers generally

disagreed with these statements. A range of 4 for each sub-item indicated that the responses ranged from the most positive response option (strongly agree) to the most negative response option (strongly disagree). Sub-item b had the most variability (*SD* = 1.06), while sub-item g had the least (*SD* = .80).

Table 4.14. *Frequency of Responses for Items 30a – 30c and Items 30e – 30g*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
a). I prefer to assign homework on a topic I covered that day, rather than previously covered topics.	9	3.0%	35	11.7%	78	26.2%	107	35.9%	69	23.2%
b). I prefer to teach an entire lesson in one day rather than distributing it over several days.	49	16.4%	126	42.3%	59	19.85	55	18.5%	9	3.0%
c). I prefer the repetitions of to-be-learned information to occur in the same day rather than on successive days.	36	12.1%	151	50.7%	76	25.1%	34	11.4%	1	<1%
e). In general, I like the repetition of a concept to occur close in time to the original presentation of the concept	1	<1%	29	9.7%	64	21.3%	158	52.7%	48	16.0%
f). Overall, I tend to distribute my repetitions of to-be-learned information over several days.	2	1%	12	4.1%	31	10.5%	178	60.3%	72	24.2%

Table 4.14. *(Continued)*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
g). I tend to repeat a topic several times in succession and rarely return to that topic at a later time.	83	27.8%	129	43.1%	47	15.7%	34	11.4%	6	2.0%

Table 4.15. *Descriptive Statistics for Sub-items on Item 30*

Sub-item	*N*	Range	Mean	SD	Variance	Skewness	Kurtosis
30a	298	1 - 5	3.64	1.06	1.11	-.48	-.41
30b	298	1 - 5	2.49	1.06	1.13	.45	-.64
30c	298	1 - 5	2.37	.85	.73	.45	-.24
30e	300	1 - 5	3.74	.85	.73	-.56	-.03
30f	295	1 - 5	4.04	.76	.57	-1.01	1.98
30g	299	1 - 5	2.17	1.02	1.05	.76	-.07

Note. For complete item and sub-item text, refer to Appendix C.

Objective 2b: Self-Reported Beliefs Regarding Massed versus Spaced Methods of Teaching

Frequency Distributions

To investigate teachers' self-reported beliefs regarding massed versus spaced teaching methods, frequency distributions were produced for items 29a to 29h, and for item 30d and are shown in Table 4.16. In addition, the percentage of respondents believing that distributed methods were more beneficial to learning, more practical to use, and more enjoyable for students (as based on the scenario items) was calculated and are shown in Table 4.21.

Beliefs about learning. With respect to learning, teachers held strong beliefs that distributed teaching methods lead to greater learning than massed teaching methods. For example, 81.8% of the respondent sample either "somewhat" or "strongly agreed" that students learn more effectively in smaller distributed blocks of time as compared to larger blocks of time, and 75.3% believed that students who used distributed study methods would score better on an exam than students who used massed study methods. Roughly 54.5% of the respondent sample believed that teaching a lesson and returning to the lesson several days later is more beneficial for learning the lesson than repeating the lesson immediately. Likewise, few teachers agreed that concepts (29.7%), activities (18.5%), and reading passages (41.2%) repeated in a massed fashion would lead to better learning than repeating them in a distributed fashion. With respect to homework, however, 73.6% either somewhat or strongly agreed that a massed homework method is more beneficial to learning than a spaced homework method.

These strong beliefs that distributed methods positively impact learning were also expressed in responses to the scenarios which were modeled after spacing effect experiments. In all six of the scenarios, the majority of the respondent sample indicated that the distributed teaching strategy would lead to better learning than the massed teaching strategy. The strongest beliefs were held for items 31 (89.2%), 36 (70.5%), 41 (71.3%), and 56 (93.1%). For items 46 and 51 only slightly more teachers chose the distributed as opposed to the massed teaching method (57.5% and 51.3%, respectively).

Beliefs about practicality. With respect to the practicality of massed versus spaced teaching methods, 73.8% agreed that distributed teaching methods were practical. However, when very specific examples were used in the scenario questions, the results of

the frequencies suggested that in most cases, teachers believed that the massed teaching methods were more practical than the distributed teaching methods. For example, on item 39 which utilized the Seabrook et al. (2005) study as the framework for the item text, 74.3% believed that the massed teaching method would be easier to use than the distributed method. Likewise, on item 51 which utilized Krug et al. (1990) as the framework for the item text, 72.5% felt that the massed teaching method was more practical to use. For item 56 which was based on Yazdani and Zebrowski (2006), approximately 63.8% also believed that the massed homework method was more practical than the distributed. The respondent sample rated Dempster's (1986) methodology, which was used as the scenario for item 44, as a 5.3 on a 10-point scale ranging from 1 (not practical at all) to 10 (extremely practical). For item 49, the respondent sample was about evenly split between massed and distributed. Item 31, which was based on Smith and Rothkopf's (1984) methodology, was the only item in which the majority of the respondents (71.5%) believed the spaced teaching methods to be more practical to use.

Beliefs about student enjoyment. With respect to student enjoyment, only 25.2% of the respondents believed that students would enjoy massed teaching methods more than spaced teaching methods. Similar results were found with the frequency distributions for items 33, 38, 49, 53, and 58 with a greater proportion of the respondents selecting distributed methods as more enjoyable for students than massed methods (85.6%, 68.3%, 59.6%, 63.4%, and 61.4%, respectively). Item 43 had a mean score 4.7 on a 10-point scale ranging from 1 (not enjoyable at all) to 10 (extremely enjoyable).

Descriptive Statistics

In addition to frequency distributions, mean, standard deviation, variance, skewness, and kurtosis were calculated for items that corresponded to this objective that were conceptualized on a continuous scale. Table 4.17 presents descriptive statistics for sub-items contained in item 29 and item 30d. The skewness of the frequency distributions indicated that the strongest positive beliefs were held for item 29b. Again, a range of 4 for each sub-item indicated that the responses ranged from the most positive response option (strongly agree) to the most negative response option (strongly disagree). Sub-item j had the most variability (*SD* = 1.09), while item 30d had the least (*SD* = .77).

Table 4.16. *Frequency of Responses for Items 29a – 29j and Item 30d*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
a). Teaching a lesson and then repeating the same lesson several days later is more beneficial to learning the lesson than had the repetition of the lesson occurred immediately.	10	3.3%	54	18.1%	72	24.1%	115	38.5%	48	16.1%
b). Students learn more effectively in smaller distributed blocks of time as compared to larger blocks of time	8	2.7%	14	4.7%	32	10.7%	113	37.7%	131	43.7%
c). A student who studies lessons in smaller blocks of time distributed over many days will likely score better on an exam than a student who studies in one large block of time.	5	1.7%	10	3.3%	59	19.7%	115	38.3%	111	37.0%
d). A concept that is repeated immediately will result in better knowledge of that concept than if the concept had been repeated the next day.	11	3.7%	90	30.1%	109	36.5%	68	22.7%	21	7.0%

Table 4.16. *(Continued)*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
e). It would be practical to teach a concept or lesson in smaller distributed time frames as opposed to longer time frames.	8	2.7%	23	7.7%	47	15.8%	139	46.6%	81	27.2%
f). Assigning homework on a topic that corresponds to a lesson taught that day is more beneficial to learning the topic than assigning homework on a topic 3 days after it is covered in class.	8	2.7%	16	5.3%	55	18.3%	106	35.3%	115	38.3%
g). Students will be more attentive during the second presentation of information if it is repeated immediately rather than if it is repeated two days later.	17	5.7%	108	36.2%	98	32.9%	59	19.8%	16	5.4%

Table 4.16. *(Continued)*

	Strongly Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Strongly Agree	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
h). Repeating an activity on the same day would be more beneficial to learning than repeating the activity a day later.	27	9.1%	133	44.8%	82	27.6%	46	15.5%	9	3.0%
i). Re-reading a passage immediately would increase learning for the information more than re-reading the passage the next.	10	3.4%	71	24.0%	93	31.4%	92	31.1%	30	10.1%
j). If left to study on their own, students would chose to study difficult concepts in succession until they were well learned before studying the easier concepts that they may already know.	79	26.3%	100	33.3%	77	25.7%	33	11.0%	11	3.7%
30d). Repeating lessons in a distributed fashion is an effective teaching strategy for the grad level that I teach.	2	1%	5	1.7%	48	16.1%	151	16.1%	92	50.7%

Table 4.17. *Descriptive Statistics for Each Sub-item on Item 29 and Item 30d*

Sub-item	*N*	Range	Mean	SD	Variance	Skewness	Kurtosis
29a	299	1 - 5	3.46	1.07	1.14	-.36	-.66
29b	298	1 - 5	4.16	.98	.96	-1.32	1.58
29c	300	1 - 5	4.06	.92	.85	-.89	.64
29d	299	1 - 5	2.99	.98	.96	.23	-.53
29e	298	1 - 5	3.88	.98	.97	-.93	.61
29f	300	1 - 5	4.01	1.01	1.02	-.96	.52
29g	298	1 - 5	2.83	.99	.98	.33	-.49
29h	297	1 - 5	2.59	.96	.92	.50	-.26
29i	296	1 - 5	3.21	1.03	1.05	-.04	-.74
29j	300	1 - 5	2.32	1.09	1.19	.53	-.41
30d	298	1 - 5	4.09	.77	.59	-.75	1.01

Note. For complete item and sub-item text refer to Appendix C.

Factor Analysis

Also to investigate this objective, exploratory factor analyses (specifically a principle components analyses) were conducted to determine whether the sub-items in item 29 represented a latent structure. Sub-items “f” and “j” were not entered into the analyses based on item text. Prior to conducting the factor analyses, sub-items “d”, “g”, “h”, and “i” were reverse scored as indicated in Chapter 3.

Two principal components analyses with varimax rotation were conducted. The first specified the extraction of two factors and this solution was then compared to a three factor solution. The factor solution that best fit the data was the two-factor solution that eliminated sub-item “a”. Screening of the data indicated that this type of analysis was appropriate. For instance, the correlation matrix (which is shown in Table 4.18) revealed that singularity was not an issue (few significance values were greater than .05, and no correlations were greater than .90). The determinant of the correlation matrix (.138) also indicated that multicollinearity was not present. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO statistic) was approximately .72 (or “good” according to Kaiser 1974 recommendations) indicating that factor analysis was appropriate, and Bartlett’s Test of Sphericity was also highly significant ($p < .001$) indicating that the *R*-matrix is not an identity matrix.

Kaiser’s criterion for extracting eigenvalues over one was met (i.e., the average communality was approximately .68 with a sample larger than 250), which indicated that a two-factor solution would best represent the structure of the items. Using the criterion of .40 or higher, seven out of eight items loaded onto one of the two factors, which accounted for approximately 57% of the variance. Table 4.19 presents the rotated factor matrix. Both factors were found to have acceptable reliability; Cronbach’s alpha for the first factor was .80, and .73 for the second.

Table 4.18. *Correlation Matrix for Selected Sub-Items on Item 29*

	29a	29b	29c	29d	29e	29g	29h	29i
29a	1.00	0.29	0.27	0.10	0.14	0.21	0.09	0.02
29b	0.29	1.00	0.54	-0.09	0.61	-0.02	-0.03	0.02
29c	0.27	0.54	1.00	-0.11	0.54	0.05	0.01	-0.03
29d*	0.10	-0.09	-0.11	1.00	-0.18	0.46	0.42	0.31
29e	0.14	0.61	0.54	-0.18	1.00	-0.11	-0.14	-0.09
29g*	0.21	-0.02	0.05	0.46	-0.11	1.00	0.53	0.30
29h*	0.09	-0.03	0.01	0.42	-0.14	0.53	1.00	0.39
29i*	0.02	0.02	-0.03	0.31	-0.09	0.30	0.39	1.00
29a		0.00	0.00	0.04	0.01	0.00	0.07	0.40
29b	0.00		0.00	0.06	0.00	0.39	0.32	0.38
29c	0.00	0.00		0.04	0.00	0.18	0.46	0.32
29d*	0.04	0.06	0.04		0.00	0.00	0.00	0.00
29e	0.01	0.00	0.00	0.00		0.03	0.01	0.06
29g*	0.00	0.39	0.18	0.00	0.03		0.00	0.00
29h*	0.07	0.32	0.46	0.00	0.01	0.00		0.00
29i*	0.40	0.38	0.32	0.00	0.06	0.00	0.00	

Note. Determinant = .138, *reverse scored item.

Table 4.19. *Rotated Factor Matrix for Sub-items in Item 29*

Item	Factor	
	"Type of Repetition"	"Block of Time"
Repeating an activity on the same day would be more beneficial to learning than repeating the activity a day later.	.801	
Students will be more attentive during the second presentation of information if it is repeated immediately rather than if it is repeated two days later.	.758	
A concept that is repeated immediately will result in better knowledge of that concept than if the concept had been repeated the next day.	.708	
Re-reading a passage immediately would increase learning for the information more than re-reading the passage the next day.	.695	
Students learn more effectively in smaller distributed blocks of time as opposed to larger blocks of time.		.849
It would be practical to teach a concept or lesson in smaller distributed time frames as opposed to longer time frames.		.846
A student who studies lessons in smaller blocks of time distributed over many days will likely score better on an exam than a student who studies in one large block of time.		.798

Analysis of Variance

Based on these results, sub-items “b”, “e”, and “c” were combined into one score labeled “block of time,” that is, large versus small blocks of time, and sub-items “d”, “g”, “h”, and “i” were combined into another score labeled “type of repetition,” that is, immediate versus delayed. Two separate one-way ANOVAs were subsequently conducted with grade group (early childhood vs. elementary vs. middle/high school) and age group (20 to 35 vs. 36 to 50 vs. older than 50) as the independent variables and either block of time score or type of repetition score as the dependent variables. An independent sample *t*-test was used to determine whether there was a significant difference between class size group (20 or less students vs. more than 20 students) on either block of time score or type of repetition score.

The one-way ANOVA on grade group and block of time score revealed a highly significant difference between grade groups, (2,252) = 11.85, $p = .000$, $n^2 = .08$. The homogeneity of variance assumption was assessed using the Levene statistic (LS). The result indicated that the homogeneity of variance assumption was not violated LS (2,252) = 1.0, $p = .37$. Post hoc analyses were conducted with a Scheffe test and revealed that those who taught early childhood ($M = 12.95$, $SD = 2.00$) and those who taught elementary school ($M = 12.45$, $SD = 2.19$) had significantly higher mean scores on this factor as compared to those who taught middle/high school ($M = 11.30$, $SD = 2.39$). Eta-squared suggested a small effect size, with 8% of the variance in block of time score accounted for by grade group. Table 4.20 shows mean block of time score by grade group. No other significant differences were found.

Table 4.20. *Mean Block of Time Score by Grade Group*

Grade Group	Mean	*N*	SD	Skewness	Kurtosis
Early childhood	12.96	67	2.00	-1.52	3.07
Elementary	12.45	104	2.19	-1.32	3.31
Middle/high school	11.30	84	2.39	-.85	1.13
Total	12.10	253	2.30	-1.13	1.86

Objective 3: Teachers' self-reported beliefs regarding the ecological validity of massed versus distributed teaching methods

This final research objective corresponded to items 32, 37, 42, 47, 52, and 57 which asked respondents whether massed or distributed teaching methods more closely resemble how teaching occurs in actual classrooms. The scenarios for which these items were based were modeled after six different methodologies used in spacing effect experiments (see Table 3.3 in Chapter 3 for details). Results are shown in Table 4.21 and indicate that the respondent sample held strong beliefs that massed teaching methods are more ecologically valid than distributed teaching methods. For example, on item 37 which was modeled after Seabrook's massed and spaced conditions in his 2005 study,

82.2% of the respondent sample believed that the massed condition more closely resembled how teaching occurs in actual classrooms. On item 47, which was modeled after Childers and Tomasello's 2002 study, about 52.0% of the respondent sample felt that the massed condition more closely resembled how teaching occurs in actual classrooms. Similar results were found on items 52 (73.1% selected the massed method as more ecologically valid) and 57 (54.9% selected the massed method as more ecologically valid), which were based on Krug's 1990 study and Yazdani and Zebrowski's 2006 study, respectively. The respondent sample rated Dempster's (1986) methodology, which was used as the scenario for item 44, as a 5.0 on a 10-point scale ranging from 1 (does not resemble real-life learning) to 10 (exactly the same as real-life learning). Item 32 corresponded to Smith and Rothkopf's (1984) study, and this was the only item where the distributed method was considered more ecologically valid than the massed method, with 76.9% of the respondent sample selecting the distributed method.

Table 4.21. *Beliefs and Preferences with Respect to Massed versus Distributed Teaching Methods*

		Percentage of Respondents Believing			
Experimental framework	Percent of Respondents Preferring Distributed Method	Distributed Method More Beneficial to Learning	Distributed Method More Practical	Distributed Method More Enjoyable for Students	Distributed Method More Ecologically Valid
Smith & Rothkopf (1984)	89.0%	89.2%	71.5%	85.6%	76.9%
Seabrook et al. (2005)	54.7%	70.5%	25.7%	68.3%	17.8%
Dempster (1987b)	76.1%	71.3%	*	**	***
Childers & Tomasello (2002)	58.4%	57.5%	50.5%	59.6%	48.0%
Krug et al. (1990)	54.2%	51.3%	27.5%	63.4%	28.7%
Yazdani & Zebrowski (2006)	92.4%	93.1%	36.2%	61.4%	45.1%

Note. Three items were on a continuous 10-point scale *M = 5.3, **M = 4.7, ***M = 5.0.

CHAPTER 5

DISCUSSION

The finding that memory is superior when to-be-remembered information is presented in a distributed fashion (i.e., with intervening material or time between repetitions) as compared to when the information is presented in a massed fashion (i.e., with no intervening material or time between repetitions) is a phenomenon known as the spacing effect. This phenomenon has been highly researched area of cognitive psychology for over 100 years, and yet review of the literature shows that there have been only a handful of studies on the spacing effect that have used ecologically valid materials, several of which investigate the spacing effect in controlled settings (e.g., Childers & Tomasello, 2002; Dempster, 1987b; Rea & Modigliani, 1985; Reder & Anderson, 1982; Reynolds & Glaser, 1964; Riches, Tomasello, & Conti-Ramsden, 2005), and a few others that have provided demonstrations of its effect in actual classroom settings (e.g., Revek, 1997, Seabrook, Brown, & Solity, 2004, experiment 3; Smith & Rothkopf, 1984; Yazdani & Zebrowski, 2006). Researchers such as Dempster have claimed that there is a failure of the educational system to apply the findings from basic research to practice; however, there is no direct evidence that teachers are not aware of the spacing effect, and do not use this knowledge to influence their teaching strategies. Moreover, missing from the literature is research on the spacing effect that examines established teaching practices with respect to repetition. Thus, the primary purpose of this research was to investigate the spacing effect with respect to teachers' established practices of repetition. Specifically, the objectives of this study were to investigate teachers': 1) self-reported use and opinion of repetition as a teaching strategy 2) self-reported preferences and beliefs

regarding massed versus distributed methods of teaching, and 3) self-reported beliefs about the ecological validity of massed versus distributed teaching methods. Data were gathered through survey research using a convenience sample of 303 teachers from across the United States.

Conclusions

With respect to the first research objective, results indicated overwhelmingly that the teachers in the respondent sample self-reported using repetition as a teaching strategy; however, self-reported reasons for using repetition differed by grade level taught and region of the country. For example, those who reported teaching exclusively at the early childhood or elementary level self-reported to a much greater extent using repetition because it helps to establish routines than those who reported teaching exclusively at the middle and/or high school level. Early childhood teachers also self-reported that they used repetition because their students enjoy it, and because it is part of their curriculum. One possibility as to why this difference occurred may be largely due to the differences in developmental levels of students in early childhood and elementary grades and those in middle or high school. While younger students made need constant repetition to grasp their everyday tasks, teachers of older student may use repetition in more of a "review" manner. In addition, those who reported teaching in the Northwest self-reported using repetition more so than those who taught in other areas of the country because it was part of their curriculum.

The self-report data also indicated that the repetition of to-be-learned information is almost never verbatim. That is, teachers reported that the second presentation of information (or the repetition) tends to be a paraphrased version of the original

presentation. Instructional items such as difficult concepts, in-class practice, facts, and portions of lessons were reported most frequently by the respondent sample to be utilized in a repetitive manner. In thinking about the most recent lesson taught, the overwhelming majority of the respondent sample self-reported using repetition in that lesson, and indicated that they would repeat something from that lesson in the same week.

The respondent sample also held very strong beliefs that repetition is an effective and important teaching strategy. In fact, teachers indicated that repetition is a strategy that can be used on a daily basis. Moreover, the respondent sample believed that repetition is useful across all subject areas and grade levels, but that it may be a strategy that is even more useful for students who seem to struggle in class. The majority of the respondent sample also indicated that repetition is enjoyable for students. Early childhood teachers were found to express higher favorability toward repetition as a teaching strategy as compared elementary and middle/high school teachers.

With respect to the timing of repetitions, in general, the respondent sample preferred using distributed over massed methods of instruction. Results were somewhat mixed with respect to method of homework assignment. While responses to one item on the survey instrument indicated that teachers preferred a massed method of homework assignment, the frequency distribution from another item indicated that teachers preferred a spaced method of homework assignment.

Teachers also reported strong beliefs that distributed instruction is more beneficial to learning than massed instruction, and that distributed methods are overall more enjoyable for students than massed methods. With respect to teaching in smaller distributed blocks of time versus larger blocks of time, early childhood and elementary

teachers held stronger beliefs than did middle/high school teachers that this method was more beneficial to learning. One interesting finding from this study, although maybe not surprising, was that overwhelmingly the respondent sample believed that massed methods of instruction were more practical to use as compared to distributed methods.

With respect to the third research objective, which investigated self-reported beliefs about the ecological validity of massed versus distributed teaching methods, the results clearly indicated that teachers believed the massed conditions used in several spacing effect studies to be more ecologically valid than the spaced conditions.

Alignment of Spacing Effect Research and Current Findings

The purpose of this section of the discussion is to directly compare findings from applied studies of the spacing effect (discussed in Chapter 2) and results from the current research on teachers' classroom practices with respect to repetition and the spacing effect. It is hoped that this discussion will identify important gaps between research and educational practice. While it is important that research guides practice, it is equally important that practice guides research. Thus, recommendations for researchers in light of these findings will be discussed in the next section.

Paraphrased Materials

Research on the spacing effect has reliably produced the effect with verbatim materials, however, there is some research to suggest that a spacing effect is not obtained when materials are paraphrased (e.g., Dellarosa & Bourne, 1985; Glover & Corkill, 1987; Krug, et al., 1990). In the current study, the overwhelming majority of teachers indicated that in most circumstances the repetition of information usually covers the same material as the original presentation of the information, but not necessarily in the exact same way.

Given this current finding, it appears that there is a gap between research and educational practice. If teachers cannot or do not present information multiple times in exactly the same manner, then more studies of the spacing effect need to be conducted using paraphrased materials to investigate the limitations of the effect.

Blocks of Time

Research on the spacing effect has consistently shown that instruction in small, distributed blocks of time produces greater learning as compared to when instruction is presented in one large block of time (e.g., Childers & Tomasello, 2002; Seabrook et al., 2005, experiment 3; Smith & Rothkopf, 1984). Results of this current study indicated that teachers were well aware of the spacing effect with respect to blocking time in the manner just described. Teachers in the sample also held very strong beliefs that the spacing effect is an effective teaching strategy, and this belief was even stronger for early childhood and elementary teachers as compared to middle/high school teachers. Similarly, teachers reported preference for utilizing distributed instruction in this manner. However, the results also indicated that teachers did not believe this method of distributed instruction to be ecological validity, which might infer that this method is not being used in classrooms. In addition, the participants did not find this type of distributed instruction practical. Thus, it appears that more research needs to be conducted to validate the self-reported results found in this research to determine whether teachers are in fact using the spacing effect in this manner.

Study

Research on study time has shown that spaced study produces better recall than massed study (e.g., Rohrer & Pashler, 2006). Teachers in this sample agreed with this

research finding, and thus were aware of the spacing effect with respect to spaced versus cram study. However, study is a metacognitive technique which has only been recently studied in relation to the spacing effect (e.g., Benjamin & Bird, 2006; Son, 2004). Greater research is needed to determine the role that metacognition plays in the spacing effect.

Homework Assignment

Several studies have found that homework or practice problems that incorporate information from previously taught lessons leads to better learning than homework that does not incorporate any type of review (e.g., Revek, 1997; Rohrer & Taylor, 2006; 2007). The current study found mixed results with respect to method of homework assignment. Given that homework (e.g., the assignment of practice problems) is a widely utilized learning strategy, particularly with students in middle or high school, it would seem that the principles of the spacing effect might easily be applied to homework assignment. Rohrer (2009) suggests that "mixed review" has much less to do with the teacher than it does with the student, and teachers do not have to alter their lesson in any way in order for the benefit to learning to occur. Given the mixed findings on this topic with this study, it would appear that this is an area where research on the spacing effect may not be influencing educational practice. Of course, the challenge is finding out how best to educate teachers on the "mixed review" strategy.

Individual Differences

The respondent sample of teachers in the current research expressed that the benefit of repetition to learning might in fact be greater for students who are struggling with the information as opposed to those who are not. This finding is in line with research from Riches et al. (2005) who found that SLI students benefited from spaced instruction

but normal language students did not. The vast majority of the research on the spacing effect, however, does not examine the spacing effect from an individual difference perspective. Given that teachers are often dealing with a classroom of students with varying ability levels, more research is needed on the spacing effect with respect to individual differences.

Recommendations for Researchers

Dempster (1988) stated that:

> the product [of experiments] must be applicable to classroom learning activities. If it cannot be demonstrated that the product generalized beyond the artificial domain of the laboratory, it will seem to have little relevance to the classroom. Such demonstrations are in fact, the most important bridge between basic research and educational practice (p. 15).

In order for researchers to create ecologically valid demonstrations of the spacing effect, a greater understanding is needed of how repetition is used in the classroom. This study attempted to shed light on this issue, and findings from this study will hopefully guide researchers who aspire to develop studies of the spacing effect that do in fact bridge research and educational practice, that is, studies that are ecologically valid. This section of the discussion is an attempt to synthesize what has been learned from a teachers' perspective regarding repetition and the spacing effect, and an attempt to recommend possible research approaches that more closely resemble actual teaching practices.

One of the most important ideas that can be taken from the current study is that early childhood and elementary teachers do not report using repetition and the spacing effect in the same manner as middle/high school teachers. What is important for researchers to consider when creating ecologically valid studies of the spacing effect is whether their methodologies are suitable not only for the developmental level of the

students to which the research is aimed, but also suitable to the types of tasks that teachers at that grade level commonly use. The research here suggests that teachers who reported teaching younger students generally self-reported that repetition was used to establish routines, because their students enjoy it, and because it is part of their curriculum. On the other hand, middle/high school teachers self-reported to a greater extent using repetition because it helps to reinforce important concepts; thus, more attention in the applied spacing effect literature needs to be given to assure that the methodology used is ecologically valid for the grade level of the subjects, and for the population to which the results will be generalized.

Second, the results from this study revealed that a greater number of spacing effect studies are needed in several key areas. The first area where there seems to be inconclusive results is with regard to paraphrased materials. Mixed results on this topic taken from the experimental literature, together with the finding here that teachers reported that repetitions are generally paraphrased suggests that more studies are needed that investigate the limitations of the spacing effect. Likewise, with the exception of Riches et al. (2005), few studies have examined the spacing effect with respect to individual difference variables. It would be useful to know if the spacing effect is more beneficial to struggling students (as this respondent sample seemed to believe), to students with different temperaments, learning abilities, or even different motivational styles or interest levels with the subject matter at hand. In addition, while several applied studies have supported the finding that smaller distributed blocks of instruction yield better learning than longer concentrated blocks of instruction, results of the present research suggest that teachers who reported teaching younger students favored this

methodology more so than teachers who reported teaching older students; moreover, while teachers held strong beliefs that this methodology is beneficial to learning, the respondent sample also reported that this methodology may not be practical to use. In fact, the teachers reported that the massed condition in Seabrook's study (2005) was more ecologically valid than the spaced condition. This finding may not only suggest that teachers are not currently using the methods that resemble the spaced conditions in their classrooms, but it may also suggest that researchers should consider revising the spaced conditions in experiments on the spacing effect. Since teachers believed that the massed conditions were more ecologically valid, maybe researchers should be comparing massed versus less massed, or conversely distributed versus less distributed conditions.

Finally, based on the results of this study, researchers may want to consider utilizing classroom/instructional items that teachers have reported using in a repetitive manner. For example, this sample of respondents reported using difficult concepts, in-class practice, facts, and portions of a lesson repetitively. If there is a natural need, or if repetition is already built into curriculums and lesson plans in this manner, experiments using these items as materials might be more readily applied to classroom practices.

Limitations of the Current Research

Online surveys are an easy and effective manner to collect data, especially if responses from a large population or geographic region are desired. However, generalizability of results may be limited due to the self-selecting nature of those who respond to online surveys. Moreover, with this study, survey respondents were recruited from online teaching forums which may be a population of teachers that is not representative of all teachers in the United States. It is likely that teachers who join

forums and networking websites may be more highly involved in their classrooms and more motivated teachers. Additionally, because a convenience sample was used, there was not equivalent representation of all demographic groups; thus, non-response bias may have occurred, particularly if those who do not respond to the survey would have respond differently than those who did respond. Item non-response is a similar limitation of this research as well, in particular if those who leave specific items blank would have responded differently than those who answered the items. Measurement errors (i.e., question wording, question order, respondent characteristics) can also affect and limit the results of a survey, as well as the sample size. Inadequate sample size can impact the precision with which results can be generalized to the overall population. Finally, this study is limited in that it uses self-reported data. The validity of self-report data can be suspect due to the possibility of response bias (e.g., participants who may respond in a more socially appealing manner). This issue may be of particular concern in this study because the cover letter and question wording may have led teachers to believe that using repetition and the spacing effect was a "better" teaching method.

Future Research

Future research investigating repetition and the spacing effect based on established teaching strategies should consider conducting classroom observations. In particular, the current research suggests that a cross-sectional study may provide useful data. In addition, a content analysis of lesson plans of teachers at different grade levels would be a valuable addition to this line of research – not only to help determine the validity of the self-reported data that was obtained from this study but to investigate whether spaced repetitions are a planned teaching strategy. It is possible that while

teachers may plan on using repetition in a spaced manner, that the classroom dynamic does not allow this activity to be carried out as planned. Or, it is possible that the reverse is true, that is, that spaced repetitions are not part of teachers' lesson plans but rather a strategy that is used on an as needed basis in the classroom based on feedback from students. Finally, it would be valuable to conduct a survey study that is similar to this current study but that addresses many of the aforementioned limitations of this current research.

Concluding Remarks

It has been the common understanding that the spacing effect is not well known by educators. This study, however, provides overwhelming data to suggest that teachers are well aware of the spacing effect. The breakdown between the research on the spacing effect and educational practice does not stem from lack of knowledge on part of the teachers, but rather from a lack of congruence between teaching practices and research methodologies. What this research has demonstrated is that not only is there a need for research to guide practice, but there is a comparable need for practice to drive research.

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APPENDICES

APPENDIX A

THE PILOT STUDY

A small-scale pilot study using survey research was conducted to explore teachers' self-reported use and perceptions of repetition and the spacing effect in the classroom. The purpose of the study was to not only gain information about classroom practices and teacher opinions, but it was also conducted as a pilot to determine the feasibility and challenges of conducting a larger-scale study on this same topic.

Method

Participants

Sixty-one teachers who were enrolled in graduate classes at Temple University participated in the pilot study. Fifty-one percent of the participants reported holding a certification in elementary education, or a dual certification in elementary education and special education. Approximately 26% of the sample reported holding certifications at the middle and/or secondary level. Ten percent of the sample reported holding a combination of elementary and middle, elementary and secondary, or all three levels. Only 5% of the participants reported special education as their only certification, and 3% reported having no certification. The remaining percentage of the sample held certifications in some combination of elementary, middle, secondary, and special education. Of the middle and secondary teachers, seven (44%) reported teaching social studies/history, six (38%) reported teaching mathematics, two (13%) reported teaching english/language arts, one (6%) reported teaching physical education, and one (6%) reported teaching science. On average, the participants reported having 5 ½ years of experience, with range of one to 27

years. Nearly all of the teachers reported teaching at public and suburban schools; eight-five percent and 83% of the sample, respectively.

Instrument

The "Teaching Style Survey" completed by each participant is presented in Appendix B. This survey instrument was comprised of four sections. In total, it contained 41 quantitative questions and four open-ended responses. The first section consisted of 6 demographic questions that included multiple-choice and numeric open-ended items. The second section of the survey asked participants to rate the frequency of each of the repetitive behaviors that they may exhibit in the classroom using the following Likert Scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always; or N/A for not applicable). The third section of items asked participants to rate their level of agreement with a series of statements using the following Likert Scale (1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, 5 = strongly agree). The last section of the survey contained a series of 4 scenarios. Each scenario consisted of an "A" version, and a "B" version that differed by use of repetition or distributed instruction. Participants had to select which version of the scenario they thought was: 1) more beneficial to student learning, 2) more practical to use 3) more enjoyable for students, and 4) more preferable to use in their classroom. Following each scenario, participants were able to justify and explain why they chose either version A or B.

Procedure. Participants were recruited through several graduate courses in the College of Education that contained a high population of teachers. Professors of these courses agreed to allow ten minutes prior to the beginning of class for distribution and completion of the survey. Each survey was accompanied by a cover letter explaining the

purpose of the study, as well as the voluntary and confidential nature of their responses. It also explained that declining to participate in the study would in no way affect their grade in the course. Each survey was collected immediately following completion.

Results. Table A.1 shows the mean rating and percentage of participants reporting "always" and "often" to questions regarding self-reported use of repetition in the classroom (i.e., items 3, 4, and 5). While about half of the participants reported reviewing a lesson in its entirety, very few teachers reported that they "often" or "always" assign the exact same reading passages or homework problems more than once. Only 7% of participants reported that they "often" or "always" do not have time to review a lesson once it is taught.

Table A.1. *Teachers' Self-Reported Use of Repetition in the Classroom*

Scale 1 (Never) to 5 (Always)	*N*	Mean	SD	% responding often/always
After teaching a lesson on a topic, I review the lesson in its entirety at a later date.	59	3.51	.88	50.8
I do not have time to review a lesson once it is taught.	54	2.13	1.01	7.4
I assign the exact same reading passage or homework problems more than once.	50	1.88	.80	2.0

Note. The base for these items does not include those participants who selected "N/A" for not applicable to their classroom.

Teachers' self-reported beliefs about repetition are shown in Table A.2 (i.e., questions 9, 11, and 15 on the survey instrument). The overwhelming majority of the participants reported that they believe repetition is critical to effective learning. Thirty percent "agreed" or "strongly agreed" that students become bored with review and repetition, and a small proportion reported that review and repetition is only beneficial to struggling students.

Table A.2. *Teachers' Self-Reported Beliefs Regarding Use of Repetition*

Scale 1 (Strongly Disagree) to 5 (Strongly Agree)	*N*	Mean	SD	% responding agree/strongly agree
Repetition of concepts and ideas is critical to effective learning.	61	4.54	.54	98.4
Students get bored with review and repetition of concepts.	60	2.83	.99	30.0
Review and repetition of concepts or lessons is only beneficial to students who are struggling with those concepts or lessons.	61	2.18	.98	11.5

Table A.3 shows the results of Scenario 1 on the survey instrument. As shown in the table, when given the choice between two teaching methods, one that uses repetition and one that does not, the majority of participants preferred the teaching method using repetition (Method A). Analysis of open-ended responses indicated that the most

prevalent theme was that “repetition establishes a routine or structure for students that is beneficial to learning in first grade.” Other themes included that repetition enhances recall, confidence, and it encourages interaction as well as participation among students. There were a few negative comments regarding the use of repetition with the mostly frequently noted being that “repetition may be boring for students.”

Table A.3. *Teachers’ Preferences Regarding Use of Repetition (Scenario 1)*

	Method	Count	Percent
Which scenario do you think would be most beneficial to student learning?	A	50	84.7%
	B	9	15.3%
Which scenario do you think is most practical to use?	A	47	82.5%
	B	10	17.5%
Which scenario do you think students would enjoy the most?	A	41	75.9%
	B	13	24.1%
If you were a 1st grade teacher, which method of teaching would you want to use in your classroom?	A	47	82.5%
	B	10	17.5%

Note. Method A uses repetition, Method B does not; see Appendix B for complete question stem.

Similar results were obtained with Scenario 4, which are shown in Table A.4. Even though the grade level used in Scenario 4 differs from Scenario 1, it is evident that

in these specific examples teachers show preference for teaching methods that use review and repetition.

Table A.4. *Teachers' Preferences Regarding Use of Repetition (Scenario 4)*

	Method	Count	Percent
Which scenario do you think would be most beneficial to student learning?	A	56	93.3%
	B	4	6.7%
Which scenario do you think is most practical to use?	A	49	81.7%
	B	11	18.3%
Which scenario do you think students would enjoy the most?	A	48	81.4%
	B	11	18.6%
If you were a 9th grade teacher, which method of teaching would you want to use in your classroom?	A	53	88.3%
	B	7	11.7%

Note. Method A uses repetition, Method B does not.

Table A.5 shows the mean rating and percentage of participants reporting "always" and "often" to questions regarding use of the spacing effect in the classroom (i.e, questions 1, 2, 6, and 7). With respect to homework assignment, teachers reported using a more massed than spaced approach. Over half of the teachers reported that they

"often" or "always" assign homework on a lesson after it is taught, but only 14% of teachers reported assigning homework on any given day that relates to a previously taught lesson. Nearly sixty-six percent of the teachers reported teaching "mini-lessons" as opposed to longer lessons either "often" or "always," and eighty-three percent reported encouraging their students to use a spaced study method for exams.

Table A.5. *Teachers' Self-Reported Use of the Spacing Effect in the Classroom*

Scale 1 (Never) to 5 (Always)	*N*	Mean	SD	% responding Often/Always
After teaching a lesson on a topic, I assign homework on that topic that is to be completed before the next class period.	53	3.51	1.19	52.8
The homework I assign on any given day relates to a lesson that I previously taught, not one that was covered that day.	50	2.70	.82	14.0
Rather than teaching a lesson in one large time frame (e.g., an hour long lesson), I tend to distribute the concepts in the lesson across smaller time frames (e.g., three 20-minute lessons).	58	3.79	.85	65.5

Table A.5. *(Continued)*

Scale 1 (Never) to 5 (Always)	*N*	Mean	SD	% responding Often/Always
After teaching a lesson on a topic, I assign homework on that topic that is to be completed before the next class period.	53	3.51	1.19	52.8
I encourage my students to study for an exam in a distributed manner rather than cramming study sessions into one large chunk of time.	53	4.28	.95	83.0

Note. The base for these items does not include those participants who selected "N/A" for not applicable to their classroom.

Table A.6 shows the results of questions 8, 10, 12, 13, and 14 on the survey instrument which focused on teachers' self-reported beliefs about using the spacing effect in the classroom. Taken as a whole, results indicate that the majority of the participants believe that spaced methods of instruction and study are practical and effective. On the contrary, three fourths of participants reported believing that homework is most effective when it corresponds to a lesson taught the same day – indicating a preference for a massed method of homework assignment.

Table A.6. *Teachers' Self-Reported Beliefs Regarding Use of the Spacing Effect in the Classroom*

Scale 1 (Never) to 5 (Always)	*N*	Mean	SD	% responding Agree/Strongly Agree
Students learn more effectively and efficiently in smaller distributed blocks of time as opposed to larger blocks of time.	61	4.13	.83	83.6
Teaching a lesson and then returning to the same lesson several days later is beneficial to my students learning.	61	4.03	.71	83.6
A student who studies my lessons in smaller blocks of time distributed over many days will likely score better on an exam than a student who studies all of the notes in one large chunk of time.	59	3.88	.79	69.5
Homework is most useful when it corresponds to the lesson that was covered in class that day.	59	3.88	.93	74.6

Table A.6. *(Continued)*

Scale 1 (Strongly Disagree) to 5 (Strongly Agree)	*N*	Mean	SD	% responding Agree/Strongly Agree
It would be practical to teach a concept or lesson in smaller distributed time frames as opposed to longer time frames.	61	3.82	.79	68.9

Results from the items listed in Table A.6 were also supported by data from Scenario 2 (which dealt with in-class reinforcement) and these findings are outlined in Table A.7. Ninety-three percent of teachers felt that the massed method of in-class reinforcement (Method A) would be most beneficial to student learning, 98% felt that it would be most practical to use, 95% believed that students would enjoy this method more, and 93% would want to use this method if he/she was a third grade teacher. Analysis of free responses for this scenario indicated that teachers chose massed repetition of in-class practice because it “provides reinforcement” and “practice” of the concepts, with many teachers also commenting that “memory for the information will be better if it is practiced immediately”. Other teachers commented that distributed practice would be “confusing or impractical”. Several teachers also noted that massed practice “allows the teacher to assess for mastery or understanding”. Finally, a few teachers noted that immediate practice allows the information to be fresh in a student’s mind, which provides better success, in effect motivating students to achieve.

Table A.7. *Teachers' Preferences Regarding Use of the Spacing Effect (Scenario 2)*

	Method	Count	Percent
Which scenario do you think would be most beneficial to student learning?	A	56	93.3%
	B	4	6.7%
Which scenario do you think is most practical to use?	A	59	98.3%
	B	1	1.7%
Which scenario do you think students would enjoy the most?	A	55	94.8%
	B	3	5.2%
If you were a 3rd grade teacher, which method of teaching would you want to use in your classroom?	A	54	93.1%
	B	4	6.9%

Note. Method A uses massed repetition, Method B uses spaced repetition.

Results from Scenario 3 shown in Table A.8 outline teachers' preferences regarding the use of the spacing effect with instruction. While the majority of teachers preferred the spaced teaching method (Method A) overall, only 38% reported that the spaced method was a more practical teaching method than the massed method (Method B). Reasons for selecting massed instruction included that massed is more practical, especially with reference to time and the ability of the students ("5th graders should be able to pay attention that long"). Teachers who selected distributed instruction felt that

this type of instruction aids learning because it is repetitive (i.e., provides review and practice), and that it helps to keep students' attention.

Table A.8. *Teachers' Preferences Regarding Use of the Spacing Effect (Scenario 3)*

	Method	Count	Percent
Which scenario do you think would be most beneficial to student learning?	A	40	66.7%
	B	20	33.3%
Which scenario do you think is most practical to use?	A	22	37.9%
	B	36	62.1%
Which scenario do you think students would enjoy the most?	A	35	66.0%
	B	18	34.0%
If you were a 5th grade teacher, which method of teaching would you want to use in your classroom?	A	34	60.7%
	B	22	39.3%

Note. Method A uses spaced repetition, Method B uses massed repetition.

Discussion. Results from this survey, particularly in light of the applied research on the spacing effect presented in Table 2.1, suggest a misalignment in some instances between the research on the spacing effect and actual classroom practice. For example, the pilot study results indicate that teachers are not only aware of the benefits of the

spacing effect to learning, but that they report using it in their instructional practices. For the most part, applied research has supported the spacing effect with classroom instruction (e.g., Seabrook, et al., 2004; Smith & Rothkopf, 1984) and instructional materials (e.g., Dempster, 1987b, Rea & Modigliani, 1985; Reynolds & Glaser, 1964). On the other hand, results from this survey suggest that teachers may not be aware of, or do not fully understand, the impact that the spacing effect has been shown to have on learning with respect to massed versus spaced homework schedules (e.g., Revek, 1997). This finding either suggests that 1) using a distributed homework schedule may not be a practical reinforcement method (as is suggested by the pilot survey data, see Table A.7) or, 2) that there is a greater need for additional demonstrations of this kind, that is, research examining reinforcement materials such as in-class practice or homework. Thus, while there is a "gap" between research and educational practice with respect to homework, it appears that there is in fact little "gap" with respect to instructional practices and instructional materials. Rather than focusing attention to these areas, applied research should focus on reinforcement schedules and their ecological validity to the classroom. Additionally, the pilot study revealed that teachers believe studying for an exam in a distributed manner is more beneficial to achievement than "cram" studying. Yet, there is only one study on the spacing effect that employs a metacognitive technique, which has many implications for study strategies used by students. Results of this survey suggest that research on the spacing effect utilizing metacognitive strategies would be useful for its application to educational practice. Table A.9 outlines this aforementioned discussion.

Table A.9. *Alignment of Spacing Effect Research and Pilot Survey Findings*

Topic	Research Finding	Pilot Survey Finding	Alignment of Research with Self-Reported Practices
Verbatim repetition versus paraphrased	Paraphrased materials do not always produce spacing effects	Teachers self-report rarely using "verbatim" passages or assign the exact same ("verbatim") homework problems	Misalignment; further investigation needed
Instruction presented in small distributed versus one large block of time	Instruction in small, distributed blocks of time produces greater learning than when it is presented in large blocks of time (e.g., Seabrook et al., 2005; Smith & Rothkopf, 1984)	Teachers are aware that small distributed blocks of instruction produces greater learning, and 65% of the sample reported using this method; however, the survey produced mixed results with regard to beliefs about practicality of this method (i.e., item 14 and Scenario 3)	Alignment
Distributed study versus cram study	Spaced study produces better recall than massed study (Rohrer & Pashler, 2006)	Teachers reported encouraging a distributed study method to students, and also reported believing that spaced study would lead to better exam performance than massed study	Alignment

Table A.9. *(Continued)*

Topic	Research Finding	Pilot Survey Finding	Alignment of Research with Self-Reported Practices
Vertical homework schedule (i.e. massed) versus distributed homework schedule	Homework that contains reinforcement from previously taught lessons (i.e., "distributed" schedule) produces greater learning (test performance) than a vertical homework schedule that does not include reinforcement from previous lessons	Teachers report using a massed schedule of homework assignment and in-class practice; also expressed beliefs that massed would be more effective than distributed and more practical to use	Misalignment

Given these interesting findings with the small-scale pilot study, it was concluded that a larger-scale replication of this study would be a useful addition to the spacing effect literature. In addition, the larger-scale study would include a revision of the initial survey instrument and allow for more complex statistical analyses such as factor analysis and analysis for differences between various demographic groups.

APPENDIX B

SURVEY INSTRUMENT FOR THE PILOT STUDY

October 23, 2007

Dear Temple University Student,

The purpose of this "Teaching Style Survey" is to collect information regarding the strategies that teachers use to foster classroom learning. The first few questions in the survey pertain to demographic information about yourself and your role as a teacher. The bulk of the questions in the survey ask about your opinion of various teaching and study strategies, and the behaviors that you exhibit in your classroom.

Completion of this survey should take approximately ten minutes, and your participation is completely voluntary. Whether or not you chose to complete this survey will have no effect on your classroom grade. If you do not wish to participate in this study, you can decline consent by not completing the attached survey. If you do, however, wish to participate in this study please complete the attached document in its entirety. All of your responses will remain completely confidential and will be combined with the responses of other teachers for research purposes. Please keep in mind that there are no right or wrong answers on this survey. The resulting data from this survey will be summarized to help gain an understanding of teachers' use of classroom strategies for enhancing learning.

Thank you for taking the time to complete this survey.

Sincerely,

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Teaching Style Survey

Demographic Information: Please check the appropriate box(es).

1. **Are you currently employed as a teacher?** □ yes □ no
2. **What type of teaching certification do you hold?**
   □ elementary □ middle □ secondary □ special education □ none
3. **If your certification is middle or secondary, which subject area(s) do you currently teach?**
   □ Mathematics □ Science □ English/Language Arts □ Foreign Language
   □ Social Studies/History □ Visual or Performing Arts
   □ Physical Education □ Computers/Technology □ Special or Gifted Education
   □ Other (please specify) _____
4. **How many years teaching experience do you have? _____**
5. **How would you classify the school where you currently teach?**
   □ public school □ private school □ charter school □ parochial school □ Other (please specify) _____
6. **In which type of geographic region is the school where you currently teach located?**
   □ Urban □ Suburban □ Rural

Questions 1 - 7 relate to the frequency of particular behaviors that you may exhibit in your classroom. Please respond using the following legend: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always. Please circle not applicable (N/A) if this behavior does not apply to your classroom.

	Never	Rarely	Sometimes	Often	Always	Not Applicable
1. Rather than teaching a lesson in one large time frame (e.g., an hour long lesson), I tend to distribute the concepts in the lesson across smaller time frames (e.g., three 20-minute lessons).	1	2	3	4	5	N/A
2. After teaching a lesson on a topic, I assign homework on that topic that is to be completed before the next class period.	1	2	3	4	5	N/A
3. After teaching a lesson on a topic, I review the lesson in its entirety at a later date.	1	2	3	4	5	N/A
4. I do not have time to review a lesson once it is taught.	1	2	3	4	5	N/A
5. I assign the exact same reading passage or homework problems more than once.	1	2	3	4	5	N/A
6. The homework I assign on any given day relates to a lesson that I previously taught, not one that was covered that day.	1	2	3	4	5	N/A
7. I encourage my students to study for an exam in a distributed manner rather than “cramming” study sessions into one large chunk of time.	1	2	3	4	5	N/A

Questions 8 - 15 relate to your opinion about various study strategies and teaching styles. Please respond using the following legend: 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, 5 = strongly agree.

	Strongly Disagree	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
8. Students learn more effectively and efficiently in smaller distributed blocks of time as opposed to larger blocks of time.	1	2	3	4	5
9. Repetition of concepts and ideas is critical to effective learning.	1	2	3	4	5
10. Teaching a lesson and then returning to the same lesson several days later is beneficial to my students' learning.	1	2	3	4	5
11. Students get bored with review and repetition of concepts.	1	2	3	4	5
12. A student who studies my lessons in smaller blocks of time distributed over many days will likely score better on an exam than a student who studies all of the notes in one large chunk of time.	1	2	3	4	5
13. Homework is most useful when it corresponds to the lesson that was covered in class that same day.	1	2	3	4	5
14. It would be practical to teach a concept or lesson in smaller distributed time frames as opposed to longer time frames.	1	2	3	4	5
15. Review and repetition of concepts or lessons is only beneficial to students who are struggling with those concepts or lessons.	1	2	3	4	5

Please read each of the scenarios below, and then answer the questions. Place the number of the scenario in the blank space. Please keep in mind that there are no right or wrong answers.

Scenario 1.

A. Mrs. Smith is a 1st grade teacher. She begins each morning by reviewing the days of the week, counting dates on the calendar, and counting the number of days the students have been in school. She repeats his routine every day for the entire school year.
B. Mrs. Smith is a 1st grade teacher. She begins each morning by beginning a new lesson.

1. Which scenario do you think would be most beneficial to student learning? _____
2. Which scenario do you think is most practical to use? _____
3. Which scenario do you think students would enjoy the most? _____
4. If you were a 1st grade teacher, which method of teaching would you want to use in your classroom? _____

Why?_____
_____
_____
_____

Scenario 2.

A. Mrs. Smith is a 3rd grade teacher. One of her lessons for the day was on how to identify even and odd numbers. At the end of the lesson, she passes out worksheets on odd and even numbers so that her students can practice the lesson just learned.
B. Mrs. Smith is a 3rd grade teacher. One of her lessons for the day was on how to identify even and odd numbers. At the end of the lesson, she passes out worksheets on counting by 100s, which is a topic that she covered the previous day.

5. Which scenario do you think would be most beneficial to student learning? _____
6. Which scenario do you think is most practical to use? _____
7. Which scenario do you think students would enjoy the most? _____
8. If you were a 3rd grade teacher, which method of teaching would you want to use in your classroom? _____

Why?_____
_____
_____
_____

Scenario 3.

A. Mrs. Smith is a 5th grade language arts teacher. When teaching vocabulary words to students she uses "mini-lessons" dispersed throughout the school day. For example, each morning students study vocabulary for 5-minutes; then right before recess she teaches another 5-minute lesson on vocabulary; finally, right before the end of the school day she gives her students a final 5-minute lesson on vocabulary.
B. Mrs. Smith is a 5th grade language arts teacher. When teaching vocabulary words to students she uses a single 15-minute session during the language arts period.

9. Which scenario do you think would be most beneficial to student learning? _____
10. Which scenario do you think is most practical to use? _____
11. Which scenario do you think students would enjoy the most? _____
12. If you were a 5th grade language arts teacher, which method of teaching would you want to use in your classroom? _____

Why?_____
_____
_____
_____

Scenario 4.

A. Mrs. Smith is a 9th grade algebra teacher. At the point of the curriculum where she is about to begin teaching a new unit on linear equations, she spends a class period reviewing, re-teaching, and repeating previous lessons from the most recent unit before beginning the new topic.

B. Mrs. Smith is a 9th grade algebra teacher. After finishing a unit, she proceeds on to the next unit in a linear fashion, without revisiting any of the concepts from the previous unit.

13. Which scenario do you think would be most beneficial to student learning? _____

14. Which scenario do you think is most practical to use? _____
15. Which scenario do you think students would enjoy the most? _____
16. If you were a 9th grade algebra teacher, which method of teaching would you want to use in your classroom? _____

Why?_____
_____
_____
_____

APPENDIX C

SURVEY INSTRUMENT*

November 26, 2008

Dear teacher,

Thank you for your interest in our study. The purpose of this survey is to collect information regarding the strategies that teachers use to foster classroom learning. The first few questions in the survey will pertain to demographic information about yourself and your role as a teacher. The bulk of the questions in the survey will ask about your opinion of various teaching and study strategies, and the behaviors that you exhibit in your classroom.

In order to be eligible for this study, you must be a teacher within the United States. Completion of this survey should take approximately 20 minutes, and your participation is completely voluntary. If you do not wish to participate in this study, you can decline consent by not advancing to the next page. If you do, however, wish to participate in this survey please navigate to the next page to begin. All of your responses will remain completely confidential and will be combined with the responses of other teachers for research purposes. Please keep in mind that there are no right or wrong answers. The resulting data from this survey will be summarized to help gain an understanding of teachers' use of classroom strategies for enhancing learning.

Thank you for your time and interest.

Sincerely,
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*Survey was slightly modified from web version to paper version for purposes of presentation

Teaching Survey: Styles and Strategies

Demographic Information

1. **What is your gender?**
   □ Male
   □ Female

2. **What is your age? _____**

3. **Are you currently a teacher?**
   □ Yes
   □ No

4. **Do you hold a certification in teaching?**
   □ Yes
   □ No →skip to question 6
   □ No, but I am currently working on my certification → skip to question 6

5. **What type of certification do you hold?**
   □ Elementary
   □ Middle
   □ Secondary
   □ Special Education
   □ I hold some combination of elementary, middle, secondary and special education
   □ Other (please specify)_____

6. **Which of the following BEST describes the subject area(s) that you CURRENTLY teach? (select all that apply)**
   □ Computers/Technology
   □ English as a Second Language
   □ Foreign Language
   □ Language Arts/English
   □ Mathematics
   □ Music
   □ Performing or Visual Arts
   □ Physical Education
   □ Science
   □ Social Science (e.g., psychology, sociology)
   □ Social Studies/History
   □ I do not teach a specialized subject area

7. **Are you certified to teach in the subject area(s) you selected?**

□ Yes
□ No
□ I am certified to teach in some, but not others

8. **Which one of the following choices BEST describes the location of the school where you currently teach?**
□ Rural
□ Suburban
□ Urban
□ Uncertain

9. **Which one of the following choices BEST describes the school setting where you currently teach?**
□ Charter
□ Parochial
□ Private
□ Public
□ Other (please specify)_____

10. **What grade level(s) do you currently teach? (select all that apply)**
□ Early Childhood (ages 0 - 2)
□ Early Childhood (ages 3 - 5)
□ Kindergarten
□ 1st grade
□ 2nd grade
□ 3rd grade
□ 4th grade
□ 5th grade
□ 6th grade
□ 7th grade
□ 8th grade
□ 9th grade
□ 10th grade
□ 11th grade
□ 12th grade

11. **How many years experience do you have at each grade level?**
Early Childhood (ages 0 - 2) _____
Early Childhood (ages 3 - 5)_____
Kindergarten _____
1st grade_____
2nd grade_____
3rd grade_____
4th grade_____
5th grade_____
6th grade_____

7th grade_____
8th grade_____
9th grade_____
10th grade_____
11th grade_____
12th grade_____

12. **What is the highest degree that you hold?**
    □ Associates
    □ Bachelor's
    □ Master's
    □ Doctoral
    □ I do not hold a degree

13. **Approximately how many students overall attend the school district where you teach? _____**

14. **On average, how many students are in your class(es)? _____**

15. **In what US state do you currently teach? _____**

Repetition in the Classroom

This section of the survey asks you to reflect on the teaching strategies that you use in the classroom.

We'd like you to think, in general, about the use of REPETITION in your classroom. REPETITION refers to any re-presentation of to-be-learned information. The second presentation may or may not be exactly the same as the first presentation.

16. **Do you use repetition as a method to enhance your students' learning?**
    □ Yes → skip to question 18
    □ No

17. **What are the reasons that you do not use repetition in your classroom as a teaching strategy? (select all that apply)**

    □ My students get bored with repetition
    □ Repetition does not pertain to the subject area that I teach
    □ Repetition is not beneficial to learning
    □ Using repetition is too time consuming
    □ Please explain any additional reasons why you do not use repetition
    _____

18. Below are some reasons why you may use repetition in your classroom. Please select all reasons that pertain to you.

I use repetition because…..

□ Concepts build on one another
□ It establishes a routine
□ It helps my students to learn
□ It helps with memorization of facts and ideas
□ It is part of my curriculum
□ My students enjoy it
□ To reinforce important concepts
□ To reinforce difficult to understand concepts
□ Other (please specify) _____

19. What is the MAIN reason why use repetition in your classroom? (select one)

I use repetition because…..

□ Concepts build on one another
□ It establishes a routine
□ It helps my students to learn
□ It helps with memorization of facts and ideas
□ It is part of my curriculum
□ My students enjoy it
□ To reinforce important concepts
□ To reinforce difficult to understand concepts
□ Other (please specify) _____

20. In general, when you use repetition during instruction, how would you characterize the second presentation (the repetition) of the to-be-learned information?

□ The repetition is exactly the same as the original presentation of the lesson
□ The repetition covers all of the same points as the original lesson, but is not presented exactly the same
□ The repetition is nothing like the original presentation of the lesson

21. Please indicate whether or not you use each of the following in a repetitive manner with the intent of enhancing your students' learning. Please select N/A if the item does not apply to your classroom.

	Yes	**No**	**N/A**
Classroom discussions	□	□	□
Difficult concepts	□	□	□
Disciplinary commands	□	□	□
Easy Concepts	□	□	□
Entire lessons	□	□	□
Exams/tests/quizzes	□	□	□
Hands-on activities	□	□	□

Homework assignments	□	□	□
In-class practice	□	□	□
Facts	□	□	□
Reading assignments	□	□	□
Portions of a lesson	□	□	□
Projects	□	□	□

22. Please rate the extent to which you agree or disagree with each statement.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
a). In general, repetition is an effective teaching strategy.					
b). Using repetition on a daily basis is a practical teaching strategy.					
c). My students enjoy when I use repetition in my classroom.					
d). The benefit of repetition to learning is greater to students who are struggling than to those who are not.					
e). Repetition is one of the most important teaching strategies.					
f). In general, I have enough time available to use repetition in my classroom as an effective teaching strategy.					
g). Repetition of lessons is beneficial to learning regardless of the subject area.					
h). Repetition is an effective teaching strategy for the grade level that I teach.					
i). Time limitations prevent me from using repetition more in my classroom.					
j). Students are attentive during the second presentation (repetition) of information.					

23. In the space provided, please describe the most recent lesson that you taught.

_____
_____
_____
_____
_____

_____
_____

Based on the lesson that you just described, answer the following questions

24. Did you use repetition as a teaching strategy in this lesson?
□ Yes
□ No → skip to question 27

25. How did you use repetition in this lesson?

26. Why did you use repetition in this lesson?

27. Do you plan on repeating this lesson or any portion of it in the future?
□ Yes
□ No → skip to question 29

28. Approximately when will the repetition occur?
□ In the same week as the original presentation of the lesson
□ In the week following the original presentation of the lesson
□ In the same month as the original presentation of the lesson
□ In more than a month following the original presentation of the lesson
□ Uncertain when it will occur
□ Other (please specify) _____

Timing of Repetitions in the Classroom

29. Please rate the extent to which you agree or disagree with each statement.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
a). Teaching a lesson and then repeating the same lesson several days later is more beneficial to learning the lesson than had the repetition of the lesson occurred immediately.					
b). Students learn more effectively in smaller distributed blocks of time as opposed to larger blocks of time.					
c). A student who studies lessons in smaller blocks of time distributed over many days will likely score better on an exam than a student who studies in one					

large block of time.					
d). A concept that is repeated immediately will result in better knowledge of that concept than if the concept had been repeated the next day.					
e). It would be practical to teach a concept or lesson in smaller distributed time frames as opposed to longer time frames.					
f). Assigning homework on a topic that corresponds to a lesson taught that day is more beneficial to learning the topic than assigning homework on a topic 3 days after it is covered in class.					
g). Students will be more attentive during the second presentation of information if it is repeated immediately rather than if it is repeated two days later.					
h). Repeating an activity on the same day would be more beneficial to learning than repeating the activity a day later.					
i). Re-reading a passage immediately would increase learning for the information more than re-reading the passage the next day.					
j). If left to study on their own, students would chose to study difficult concepts in succession until they were well learned before studying the easier concepts that they may already know.					

30. Please rate the extent to which you agree or disagree with each statement.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
a). I prefer to assign homework that reinforces the topic I covered that day, rather than previously covered topics.					
b). I prefer to teach an entire lesson in one day rather than distributing it over several days.					

c). I prefer the repetitions of to-be-learned information to occur in the same day rather than successive days.					
d). Repeating lessons in a distributed fashion is an effective teaching strategy for the grade level that I teach.					
e). In general, I like the repetition of a concept to occur close in time to the original presentation of the concept.					
f). Overall, I tend to distribute my repetitions of to-be-learned information over several days.					
g). I tend to repeat a topic a few times in succession and rarely return to that topic at a later time.					

Scenarios

The next set of questions presents you with two short scenarios that contain different teaching styles and strategies. Please read each passage and then answer the questions that follow. Please select only one answer for each question, and keep in mind that there are no right or wrong answers.

A) You enroll in an 8-hour mini-course on introductory statistics. This course is completed within this one day; that is, it begins at 9:00 a.m. and is finished at 5:00 p.m.

B) You enroll in an 8-hour mini-course on introductory statistics. This course is completed in four days, with each day consisting of a 2-hour session; that is, it begins at 9:00 a.m. and is finished at 11:00 a.m. each day for four successive days.

31. On a subsequent test of introductory statistics, which course format (A or B) would be more likely to help you obtain a higher score on the test?

□ A

□ B

32. Which course format (A or B) most closely resembles how teaching is conducted in "real-life" classrooms?

□ A

□ B

33. Which course format (A or B) would you enjoy more?

□ A

□ B

34. From a practical standpoint, which course format (A or B) do you think would be easier for an instructor to teach?

□ A

□ B

35. If you were teaching this course, which course format would you prefer?

□ A

□ B

A) Mr. Smith is an elementary school teacher who is teaching a lesson on reading skills. The goal of the lesson is to help students learn new sight words, and increase blending and segmentation of sounds. Over the course of two weeks, he teaches reading skills daily in three 2-minute mini-lessons with the following schedule: one in the morning, one mid-day, and one just before school ends for the day.

B) Mr. Smith is an elementary school teacher who is teaching a lesson on reading skills. The goal of the lesson is to help students learn new sight words, and increase blending and segmentation of sounds. Over the course of two weeks, he teaches reading skills daily in one 6-minute mini-lesson that occurs mid-day.

36. On a subsequent test of reading skills, students who learned according to which teaching method (A or B) would score higher on the test?

□ A

□ B

37. Which method (A or B) most closely resembles how teaching is conducted in "real-life" classrooms?

□ A

□ B

38. Which teaching method (A or B) would students enjoy more?

□ A

□ B

39. From a practical standpoint, which teaching method (A or B) is easier for the teacher?

□ A

□ B

40. If you were an elementary school teacher, which teaching method would you prefer?

□ A

□ B

A) Mrs. Doe is a middle school teacher who is teaching her students a new study strategy for learning vocabulary words. Each student receives a booklet with 114 pages. On each page is a vocabulary word with its definition. The vocabulary words are repeated 3 times each within the booklet, one right after another. Students are instructed to study each page for 7 seconds.

B) Mrs. Doe is a middle school teacher who is teaching her students a new study strategy for learning vocabulary words. Each student receives a booklet with 114 pages. On each page is a vocabulary word with its definition. The vocabulary words are repeated 3 times each within the booklet, with 37 pages between each repetition. Students are instructed to study each page for 7 seconds.

41. On a subsequent test of vocabulary, students who studied with which method (A or B) would score higher on the test?

□ A

□ B

42. On a scale of 1 - 10, how closely does having students study in this manner resemble what occurs in a "real-life" learning situation?
1 = does not resemble real-life learning, 10 = exactly the same as real-life learning

Rating 1 2 3 4 5 6 7 8 9 10

43. On a scale of 1 - 10, how much would students enjoy studying vocabulary in this manner?
1 = would not enjoy at all, 10 = extremely enjoy

Rating 1 2 3 4 5 6 7 8 9 10

44. On a scale of 1 - 10, how practical would it be to have students study vocabulary using this method?
1 = would not be practical at all, 10 = extremely practical

Rating 1 2 3 4 5 6 7 8 9 10

45. If you were a middle school teacher, which study method would you encourage?

□ A

□ B

A) Miss Linda is a teacher in a daycare center who works with 2-year old children. As an early childhood teacher one of her primary responsibilities is to teach her students novel words (e.g., nouns and verbs) through individual play sessions. She exposes a new word in 4 play sessions on a single day.

B) Miss Linda is a teacher in a daycare center who works with 2-year old children. As an early childhood teacher one of her primary responsibilities is to teach her students novel words (e.g., nouns and verbs) through individual play sessions. She exposes a new word in 4 play sessions, each on a different day.

46. On a subsequent test of word production, students who learned according to which teaching strategy (A or B) would produce more words?

□ A

□ B

47. Which teaching strategy (A or B) most closely resembles how teaching is conducted in "real-life" classrooms?

□ A

□ B

48. Which teaching strategy (A or B) would students enjoy more?

□ A

□ B

49. From a practical standpoint, which teaching strategy (A or B) is easier to use in a daycare classroom?

□ A

□ B

50. If you were a day care teacher, which teaching strategy would you prefer?

□ A

□ B

A) Mr. Chan is a high school English teacher. He would like his students to remember main ideas from a 600 word essay. He asks his students to read the essay and afterwards to re-read the essay immediately.

B) Mr. Chan is a high school English teacher. He would like his students to remember main ideas from a 600 word essay. He asks his students to read the essay, and then to re-read the essay one week later.

51. On a subsequent test of recall, students who learned according to which method (A or B) would remember more main ideas from the passage?

□ A

□ B

52. Which method (A or B) most closely resembles how teaching is conducted in "real-life" classrooms?

□ A

□ B

53. Which method (A or B) would students enjoy more?

□ A

□ B

54. From a practical standpoint, which method (A or B) is easier to use in the classroom?

□ A

□ B

55. If you were a high school English teacher, which method would you prefer?

□ A

□ B

A) Ms. Baker is a high school mathematics teacher. On any given day she assigns homework that corresponds to the topic that she taught in class that day.

B) Ms. Baker is a high school mathematics teacher. On any given day she assigns homework that corresponds to the topic that she taught in class that day, along with reinforcement of topics that were covered previously.

56. On a subsequent mathematics test, students who received homework according to which schedule (A or B) would score higher?

□ A

□ B

57. Which method (A or B) more closely resembles how homework is assigned in "real-life" classrooms?

□ A

□ B

58. Which method of homework assignment would students enjoy more?

□ A

□ B

59. From a practical standpoint, which method of homework assignment (A or B) is easier to use in the classroom?

□ A

□ B

60. If you were a high school Mathematics teacher, which method of homework assignment would you prefer?

□ A

□ B

61. Did this survey influence your knowledge about using repetition and distributed instruction as a teaching strategy?

□ Yes

□ No

□ Uncertain

62. Will you use massed and distributed instruction differently in your classroom as a result of completing this survey?

□ Yes

□ No

□ Uncertain