Richmond, A. S., Cummings, R., & Klapp, M. (2008). Transfer of the method of loci, pegword, and keyword mnemonics in the eighth grade classroom. *Researcher, 21*(2), X-X.

Transfer of the Method of Loci, Pegword, and Keyword Mnemonics in the Eighth Grade Classroom

Aaron S. Richmond
Metropolitan State College of Denver

Rhoda Cummings
University of Nevada-Reno

Michael Klapp
Washoe County School District

The goal of this study was to understand whether students could transfer use of a mnemonic under both specific and general transfer conditions. One-hundred and eight eighth-grade students were randomly assigned to one of four conditions (e.g., method of loci, pegword, keyword, or free study). Over a 2-week period, students learned their assigned mnemonic device, were tested on their ability to transfer their mnemonic under a specific transfer condition (study metal alloy uses) and a general transfer condition (study Revolutionary War battle events). The results of this study indicate that students who used the keyword mnemonic could transfer the use of a mnemonic under specific transfer and general transfer conditions. The results of this study provide evidence to researchers and teachers that by teaching the keyword mnemonic to eighth-grade students may increase their repertoire of memory strategies which in turn enhances academic performance.

Keywords: *Mnemonics, Middle School Science, Transfer*

Many researchers have developed various techniques for effective study strategies. Studies demonstrating the effectiveness of such strategies have included investigations of the following: (a) note taking in high school English (Hale, 1983), (b) knowledge organization strategies in science instruction (Mintzes, Wandersee, & Novak, 1997), (c) comprehension monitoring in reading instruction (Hacker, 1998), and (d) memory techniques (mnemonics) in science instruction in middle school, high school, and adult education (Pressley & Dennis-Rounds, 1980; Roediger, 1980; Scruggs & Mastropieri 2000). Although many of these study strategies have been found to be effective in increasing students' academic performance, other studies have demonstrated that mnemonic instruction, a specific memory technique, may be one of the more effective ways to improve eighth-grade science knowledge (Levin, Morrison, McGivern, Mastropieri, & Scruggs, 1986; Scruggs & Mastropieri, 1992). Thus the purpose of this

All correspondence should be sent to Dr. Richmond at: Metropolitan State College of Denver, Department of Psychology, Campus Box 54, P.O. Box 173362, Denver, CO, 80217-3362, e-mail: arichmo3@mscd.edu, phone: 303-556-3085, fax: 303-556-2169.

study is to determine if students can learn a given mnemonic and then transfer use of this mnemonic to other content domains. Three specific types of mnemonics were investigated: the method of loci, the pegword method, and the keyword method.

REVIEW OF THE LITERATURE

MNEMONICS

Mnemonics are memory aids that assist one in remembering specific information by using a process, strategy, or technique that enables a person to improve memory (Higbee, 1977). Mnemonics are comprised of mental cues that are created to make information retrievable. This is done by associating a similar or dissimilar piece of information (mental cue) with the information needed to-be-remembered (Bellezza, 1996; Bjorklund, 2000).

There are three main types of mnemonics described in the literature (Bellezza, 1996). These include the method of loci (Yates, 1966), the pegword method (Roediger, 1980), and the keyword method (Atkinson, 1975).

THE METHOD OF LOCI. The method of loci mnemonic is the oldest mnemonic, which involves three steps (Yates, 1966). First, learners are required to memorize a "series of distinct loci along a familiar pathway" (Moe & De Beni, 2005, p. 95). Second, learners are required to convert to-be-remembered words, such as George Washington, into mental representations. Next, learners are required to "deposit the image along some salient location along the path" (Roediger, 1980, p. 559). For example, George Washington would be sitting in a desk. Learners are then instructed to take a mental walk through the room to recall the target information. Then, when learners are asked to recall George Washington, they visualize him sitting on a desk (Yates, 1966).

THE PEGWORD METHOD. The pegword method is a two-stage process. In the first stage, learners are asked to learn 10 number-rhyme pairs (e.g., *one* is a *bun*, *two* is a *shoe*, and *three* is a *tree,* etc.). In the second stage, learners are given a picture or asked to visualize the to-be-remembered item linking the rhyming words to the to-be-remembered item. For example, if the to-be-remembered item is George Washington, the image of President Washington holding a bun could be shown as a picture or the student would be instructed to create a vivid mental image of this picture. When the learner must recall the first president, this image comes to mind and he recalls George Washington (Roediger, 1980; Scruggs & Mastropieri, 2000).

THE KEYWORD METHOD. The keyword mnemonic requires two stages: an acoustic link stage and an imagery link stage (Atkinson, 1975; Levin, 1981). First, the learner is given a 'keyword' that is acoustically similar to and that can be visualized as interacting with the item to-be-remembered. For example, the word *perro* is Spanish for dog. An acoustically similar and visually represented word would be *pear*. In the second stage, the learner would form the visual image of the keyword *pear* and the target word *perro* interacting in some way. Thus, for *perro* a learner might visualize a dog holding a pear in its mouth. When the learner is asked to recall the definition of *perro,* the visualization is invoked and she can then recall the definition (Atkinson, 1975; Levin, 1981).

TRANSFER

"How do we make sense of the ways in which people use knowledge in circumstances different from the

circumstances in which that knowledge was developed?" (Shoenfeld, 1999, p. 7). As Shoenfeld stated, it seems prudent and important to investigate how students learn one skill or set of information and then apply this skill to new situations.

Transfer refers to the student's ability to use previously learned knowledge or strategy to solve another problem (Gray & Orsanu, 1987). Transfer is also divided into two distinct categories—specific transfer and general transfer. *Specific transfer* is the ability to transfer knowledge, skills, or strategies to a new problem that is similar to the original context of the learned knowledge, skill, or strategy (Gray & Orsanu, 1987). *General transfer* occurs when the learner transfers knowledge, skills or strategies to a new problem or learning task that is dissimilar in context to the context in which the skill or strategy originally was learned (Gray & Orsanu, 1987).

MNEMONICS IN EDUCATIONAL SETTINGS

A review of literature on mnemonics and mnemonic use in middle school settings reveal some specific problems (Levin, 1993). First, there is the problem of conducting mnemonic research in the laboratory rather than in the school (Levin, 1993). Second, and more important, is the question of whether middle school students can independently transfer mnemonics learned in one setting to a different setting (Cormier & Hagman, 1987; Levin, 1993; Schoenfeld, 1999).

LAB TO FIELD RESEARCH. Levin (1993) reviewed mnemonic research over the past 20 years and assigned a grade of A, B, C, D, or F to many different aspects of mnemonic research. Levin assigned an "A" grade to the area of mnemonic research addressing the effects of applying mnemonics to learning disabled (LD) students' achievement. However, he assigned an "F" grade to mnemonic research in educational settings. Levin concluded that not only should researchers further the theoretical investigation of mnemonic devices in all aspects of learning, but more importantly they should take basic research conducted in a laboratory setting and apply it to real-world educational settings. Congruent with Levin's (1993) comments, Scruggs and Mastropieri (2000) have reported that out of 34 mnemonic studies only 10 have been conducted in educational settings, such as the public school classroom. The conclusions and recommendations made by Scruggs and Mastropieri (2000) that are strengthened by Levin (1993), who provides a rationale for conducting quality research on the use of mnemonics in the classroom.

MNEMONIC TRANSFER. To date, only two studies have investigated the issue of transfer of mnemonics by middle school students (see Pressley & Dennis-Rounds, 1980; Scruggs & Mastropieri, 1992). Scruggs and Mastropieri (1992) studied the acquisition, maintenance and generalization (i.e. transfer) effects of mnemonic training of science information with LD students. They found that once trained in the keyword method, LD students were able to transfer this strategy to new, but similar science information (specific transfer). This study has important implications for the present study. Scruggs and Mastropieri are the only researchers to study mnemonic transfer of science vocabulary in middle school students and they found significant differences between controls and students who used mnemonics on the transfer task.

Pressley and Dennis-Rounds (1980) investigated keyword mnemonic transfer at two different age levels (middle school vs. high school students). The researchers found that when students were trained in the keyword mnemonic, only the high school students were able to successfully

transfer the memory strategy to other dissimilar information (general transfer). However, when middle school students were prompted (provided pictures) to use the keyword mnemonic, they too were able to transfer the memory strategy to new information. Results of this study have two key implications for the present study. First, middle school students were able to transfer the keyword method to dissimilar material (general transfer) only when prompted with visual representations of the mnemonic. Second, as in Scruggs and Mastropieri's study, unlike the present study, the researchers did not look at the differential effects of various mnemonic methods and did not differentiate between general and specific transfer tasks.

In sum, two major problems revealed in the literature on mnemonic use in education have implications for the present study. First, there is a need to conduct mnemonic research in schools rather than in labs (Levin, 1993; Mastropieri & Scruggs, 1998). Second, there are no studies that investigate specific and/or general transfer of use of the three mnemonic methods of (a) the method of loci, (b) the pegword method, and (c) the key word method. .

RESEARCH QUESTIONS

Based on the above stated problems, the following research questions were asked:

RQ#1: Can students transfer use of a mnemonic to learn new information that is similar (specific transfer) to the originally studied science vocabulary?

RQ#2: Can students transfer use of a mnemonic to new information that is dissimilar (general transfer) to the originally studied science vocabulary?

RQ#3: Are there differences between specific and general transfer tasks based on type of mnemonic method?

METHOD

PARTICIPANTS

One hundred and eight middle school students in eighth-grade science classes participated in this study. In each class, students were randomly assigned to one of three mnemonic conditions (method of loci, pegword and keyword) and to one control condition (free study). Random assignment was consistent within each classroom with an attempt to assign an equal number of students to each of the four conditions. The sample included 50% males and 50% females with a diverse range of ethnicity (60.40% Caucasian, 22.00% Hispanic, 6.60% Asian, 4.40% Native American, 3.30% African American, and 3.3% other). On average, students were 13 years and 7 months old.

MEASUREMENTS

DEMOGRAPHIC SURVEY. Students were given a short demographic survey providing information about gender, birth date, and ethnicity. The survey was adapted from questions used in studies by Scruggs, Mastropieri, Sullivan, and Hesser (1993).

PRIOR KNOWLEDGE TEST. Similar to that of Hwang and Levin (2002), this study used a prior knowledge pretest in order to determine whether students in the four conditions had similar or dissimilar levels of prior knowledge. All of the vocabulary terms taught in the specific transfer task (science vocabulary), and the general transfer tasks (history facts) were combined into one matching test that included a total of 20 matching questions.

METAL ALLOY TEST. The structure of this test was also adopted and modified from a combination of measures used in Rummel, Levin, Woodward (2003). In this measure, students were given a list of 10 metal alloys (e.g., manganese, duriron, invar) with a

corresponding use for each alloy (e.g., *manganese* = railroads). One point was awarded when students correctly matched each allow with its use. There was a total of 10 points possible.

REVOLUTIONARY WAR TEST. This test was adopted and modified from a measure used in a study by Brigham, Scruggs, and Mastropieri (1995). Students were given 10 Revolutionary War battle names with corresponding events (e.g., *Yorktown* = last major battle of the war). One point was awarded for correctly matching the battle name to the description. There was a total of 10 points possible.

It should be noted that both the metal alloy and Revolutionary War tests were constructed specifically for this study. Thus, there are no reliability and validity statistics for these two measures. However, both measures do appear to have face validity (e.g., the ability of these measures to test knowledge about metal alloys and Revolutionary War battles) (Bordens & Abbot, 2005).

DISTRACTOR TESTS. In order to control for short-term memory effects, a distractor test (a word search) was developed based on a similar measure used by Carney and Levin (2000). Short-term memory effects occur when the student is able to rehearse the to-be-remembered information from the end-of-the-study time to the testing time (Carney & Levin, 2000**).** There were two separate word searches used containing words associated with the subjects of math and biology. Each word search contained 15 words incorporated into a 10 by 10 matrix of 100 letters.

MATERIALS

INITIAL MNEMONIC LEARNING. As part of a separate study, students were taught to use each of the three mnemonics. To teach students how to use the mnemonics, students in each of the four conditions received one booklet with examples of mnemonics and instructions. The science vocabulary materials that were used to initially teach the student were drawn from a popular eighth-grade physical science textbook written by McLaughlin and Thompson (1999). The science vocabulary primarily focused on states of matter and properties of gases. For example, *Archimedes' Principle* states "the buoyant force on an object in a fluid is equal to the weight of the fluid displaced by the object" (McLaughlin & Thompson, 1999, p. 235).

Specific transfer. To test for specific transfer, students in each of the four conditions received a booklet containing 16 collated 8 ½ by 11-inch pages. For each condition, a booklet was adapted and modified from Carney, Levin, and Morrison (1988). Each booklet contains four major sections: (1) introduction, (2) strategy description, (3) actual study, and (4) testing. In the *introduction* section, students were given descriptive information about the study. For example, students were told that they would learn a memory strategy, practice the strategy, and then be tested on the studied material. During the *strategy description,* students in each condition were given a brief overview and description of their assigned strategy (e.g., method of loci, pegword, keyword, or free study). Following this, students participated in the *actual study* section in which they studied the metal alloys. In the final *testing* section, students were tested. As a reminder, specific transfer occurs when the learner is taught to use a learning strategy for one learning task and then is required to apply the same learning strategy to a learning task that is similar in content to the original task (Gray & Orsanu, 1987). Therefore, if the originally studied material was information about physical science vocabulary, then the

specific transfer materials should be similar in nature. Since the originally studied material was derived from McLaughlin and Thompson's (1999) physical science textbook, other science information contained in this book should be similar in nature to the original material. The specific transfer materials consisted of information about metal alloys and their respective uses. For example, the metal *manganese* is used in railroads (see Table 1 for a complete list and description of the metal alloys). There are 10 different alloys with one use for each alloy.

Table 1. *Specific Transfer Task Materials*

Metal Alloy	Use	Loci	Pegwords	Keywords
Manganese	Railroads	Door	1-Bun	Man & Geese
Duriron	Pipes	Chair	2-Shoe	Sir Byron
Nikel	Gears	Sink	3-Tree	Nickel
Invar	Measuring Tapes	Clock	4-Door	Engine
Permalloy	Radios	Desk	5-Hive	Worm Alley
Stainless	Knives	Computer	6-Sticks	Stanley
High Speed	Saw Blades	TV	7-Heaven	High Speed
Solder	Electronic Wires	Projector	8-Gate	Soldier
Pewter	Dinner Plates	Aquarium	9-Vine	Scooter
Wrought Iron	Fences	Filing Cabinet	10-Hen	Rotting Iron

Note. This material is from McLaughlin and Thompson (1999).

Table 2. *General Transfer Materials*

Battle	Event	Loci	Pegwords	Keywords
Ticonderoga	They captured cannon, which would be used later.	Door	1-Bun	Tiger
Saratoga	The French helped them.	Chair	2-Shoe	*Sarah in a toga*
Cowpens	They hid behind a hill for an ambush.	Sink	3-Tree	Cow
Trenton	They attacked on Christmas night.	Clock	4-Door	Tent
Brandywine	They stopped an attack on the capitol.	Desk	5-Hive	Brandy
Vincennes	They waded through a flood to get to the battle.	Computer	6-Sticks	Fence
Cahokia	Fought at the site of a large Indian mound.	TV	7-Heaven	Coke
Yorktown	Last major battle of the war.	Projector	8-Gate	Fork or cork
Camden	They were sick because of the bad food.	Aquarium	9-Vine	Camel
Paoli	They were attacked while they were sleeping.	Cabinet	10-Hen	Paycheck

Note. The battles and events are from Brigham et al. (1995).

GENERAL TRANSFER. To test for general transfer, students in each of the four conditions received a booklet containing 16 collated 8 ½ by 11-inch pages with the same format described above. General transfer occurs when the learner is taught to use a learning strategy under one specific learning content (e.g., science vocabulary) and then is required to apply the same learning strategy to a different learning task that is dissimilar from the original content (Gray & Orsanu, 1987). Thus, to devise materials to be used in the *General Transfer Task*, the learning content must be different from the original science content of science vocabulary used in the initial mnemonic learning task. In a study by Brigham et al. (1995), the authors used the battle names of

the American Revolutionary War with associated battle events to test the effects of different mnemonics on LD eighth-grade students. Considering the definition of general transfer, historical battles should be epistemologically different from physical science vocabulary. Therefore, a random selection of 10 of the 14 battles described in Brigham et al. (1995) was selected for the general transfer task (see Table 2).

PROCEDURES

INITIAL MNEMONIC LEARNING PHASE. The initial mnemonic learning phase was part of a separate experiment in which students in all four conditions received the same format for learning their respective mnemonic. However, the content of the directions for each mnemonic differed. For the *method of loci*, the instructional material was based on procedures in studies described by Wang and Thomas (2000) and Roediger (1980). The assigned locations were familiar classroom locations (e.g., desk, door, sink, etc.). For the *pegword* condition, initial mnemonic instructional materials were developed by adapting techniques used in studies by Scruggs et al. (1993). For the *keyword* condition, the procedure was developed based on the methods used in studies by Carney and Levin (1994). Finally, for the free study condition (control group), the procedure used was adopted from studies conducted by Konopak and Williams (1988).

SPECIFIC TRANSFER PHASE. Students were first given a brief review of their respective mnemonic method or free study method. Students were asked to study 10 metal alloys and their respective uses by using the mnemonic method or free study method. For example, students who were trained in the keyword method were asked to generate keywords for each metal alloy and then write down an interactive sentence that included the keyword. For example, the keyword for *manganese* was *man and geese* and they described a man and a geese walking down railroad tracks. Refer to Table 1 for student examples of their mnemonic cues for each of the mnemonic conditions. Students were then given 20 min to create their mnemonic and study the metal alloy material. Following the study period, students were given a 3-min distractor task. Students then completed a 12-min metal alloy test.

GENERAL TRANSFER TASK. For this task, students were given a brief review of their respective mnemonic or free study methods. Students were asked to study 10 Revolutionary War battles and their defining event using their respective mnemonic device. For example, students who were trained in the pegword method were asked to generate pegwords for each battle, and then write down an interactive sentence of the pegword, battle name, and battle description. For example the keyword for *Cahokia* could be coke and the learner would describe an image of an Indian drinking a coke in the middle of a battle. Refer to Table 2 for student examples of their respective mnemonic cues. Students were given 20-min to create their mnemonic and study this material using the mnemonic. Following the study period, students were given a 3-min distractor task. Students then completed a 12-min Revolutionary War test.

RESULTS

PRIOR KNOWLEDGE PRETEST

Two separate one-way Analyses of Variances (ANOVA) were used to detect possible differences in the amount of prior knowledge among students in each of the four conditions (e.g., method of loci, pegword, keyword, and free study). There

were no differences detected among the four conditions on the Metal Alloy Test ($F(3, 104) = .312$, $p > .05$, $\square^2 = .009$) and there were no differences detected among the four conditions on the Revolutionary War test ($F(3, 104) = 2.15$, $p > .05$, $\square^2 = .06$).

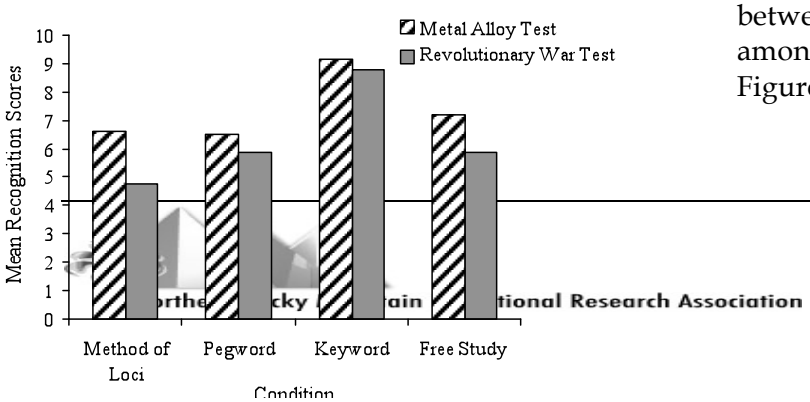
Table 3. *Means and Standard Deviations of the Metal Alloy and Revolutionary War Tests*

Condition	Metal Alloy Test		Revolutionary War Test	
	M	*SD*	*M*	*SD*
Method of Loci	6.60	3.30	4.75	3.30
Pegword	6.52	2.49	5.88	3.18
Keyword	9.16	1.65	8.79	1.69
Free Study	6.60	3.23	5.88	3.36

RESEARCH QUESTION 1

To determine if students could transfer use of a mnemonic (loci, pegword, and keyword) to learn new information (metal alloys) that was similar (specific transfer) to the originally studied science vocabulary, a one-way ANOVA was conducted. The ANOVA revealed a significant effect ($F(3, 96) = 5.54$, $p < .01$, $\square^2 = .15$), indicating that there was a difference among conditions in the mean number of metal alloy uses recognized (see Figure 1 and Table 3). Post hoc analyses were conducted using Dunnet's T3 pairwise (Toothaker, 1991). Students in the keyword condition recognized significantly more uses of metal alloys than did students in the method of loci, pegword, and free study conditions *ps* < .05; see Table 3). The other conditions did not significantly differ from one another (see Figure 1).

Figure 1. Average Recognition by Condition



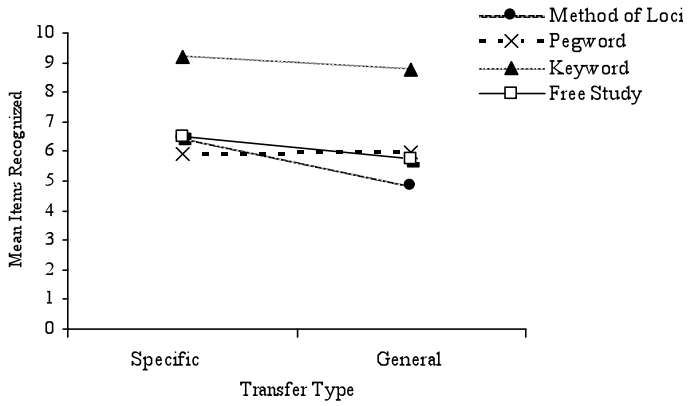
RESEARCH QUESTION 2

To determine if students could transfer use of a mnemonic to new information (Revolutionary War battle events) that was dissimilar (general transfer) to the originally studied science vocabulary, a one-way ANOVA was conducted to examine differences among the four conditions on the mean number of Revolutionary War battle events recognized. The ANOVA revealed a significant effect ($F(3, 92) = 7.72$, $p<.001$, $\square^2 = .20$), indicating a difference among conditions in the mean number of Revolutionary War battle events recognized (see Figure 1 and Table 3). Post hoc analyses reveal that students in the keyword condition recognized significantly more Revolutionary War battle events than did students in the method of loci, pegword, and free study conditions ($p < .05$; see Table 3 and Figure 1). The other conditions did not significantly differ from one another (*ps*>.05).

RESEARCH QUESTION 3

To assess whether there were differences between specific and general transfer tasks based on mnemonic type, four paired sampled t-tests were conducted for each condition. These analyses were conducted on the scores on the metal alloys test (specific transfer task) and the Revolutionary War test (general transfer task). There were no significant differences between specific and general transfer tasks among any of the conditions (*ps*>.05; see Figure 2).

Figure 2. Specific Vs. General Transfer



DISCUSSION

PRIOR KNOWLEDGE PRETEST

Results indicate that prior to teaching students how to use their respective mnemonic or free study method, students in each of the four conditions had the same amount of knowledge about metal alloys and their uses, and Revolutionary War events. These findings indicate that when students' knowledge increased on posttest measures, the increase was attributable to the mnemonic method, rather than to prior knowledge of information.

RESEARCH QUESTION 1

The intent of research question 1 was to examine students' ability to transfer use of a mnemonic to learn new information that was similar (specific transfer) to the originally studied science vocabulary. Students in the keyword condition recognized significantly more uses of metal alloys (specific transfer) than did students in the method of loci, pegword, and free study conditions. There was no difference among any of the other conditions.

On the surface, the results of the present study indicate that the keyword mnemonic is the only mnemonic to transfer under specific transfer conditions. However, an in-depth analysis of these results is warranted. Students in the keyword mnemonic may have been more successful at transferring their mnemonic because of the initial mnemonic learning. If students in the keyword condition were the only students to *successfully* learn the mnemonic, then it is possible that students in the keyword condition would be the only students to successfully transfer the use of the mnemonic. Since the amount of instructional time, examples, and opportunities to practice affect the ability to transfer mnemonics (Gick & Holyoak, 1987; Schmidt & Bjork, 1992), it is possible that students in the method of loci and pegword conditions may need more instructional time, examples and opportunities to practice to learn how to use the mnemonic properly. Presumably, it is difficult to transfer use of a mnemonic if there is lack of understanding of how to use the mnemonic in the first place (i.e., possibly what students in the method of loci and pegword conditions experienced).

In conclusion, these findings suggest that when students are self-taught the keyword mnemonic, they can transfer use of the mnemonic under specific transfer conditions. A major aim of education is to teach students how to apply the knowledge that they gain in school to different but similar situations. Hence, the finding that students can transfer the keyword mnemonic to study a different set of similar materials directly supports this educational goal.

RESEARCH QUESTION 2

The purpose of the second research question was to determine if students could transfer use of a mnemonic to new information that is dissimilar (general transfer) to the originally studied science

vocabulary. Students in the keyword condition recognized significantly more Revolutionary War battle events than did students in the method of loci, pegword, and free study conditions. There were no other differences detected. Again, this finding may be due to the possibility that students in the keyword condition were the only group who successfully learned their mnemonic in the first place and thus were able to successfully transfer the use of the mnemonic to dissimilar information.

The implications of these findings suggest that even when students are self-taught the keyword mnemonic, they can transfer the use of the mnemonic under general transfer conditions. The educational implications of these findings suggest that eighth-grade science teachers might teach their students to use the keyword mnemonic to improve their science knowledge. More importantly, findings indicate that students can transfer the use of the keyword mnemonic to study not only science content, but also to study history content (or other dissimilar information).

RESEARCH QUESTION 3

To answer this research question, the present study sought to detect if differences existed between specific and general transfer tasks based on type of mnemonic condition. Among all conditions, there were no differences between performances on the metal alloys test (specific transfer task) and the Revolutionary War test (general transfer task).

There were no differences among all conditions on the specific and general transfer tasks. Students in the keyword condition effectively transferred their mnemonic to both specific and general transfer tasks but students in the method of loci, pegword, and free study condition did not successfully transfer to either specific or general tasks. Prior research identifying factors that influence transfer (i.e., context free vs. context bound) may support this finding (Alexander & Judy, 1988). Since students in the keyword condition were consistent with their performance on both tasks, it is possible that they were aware that the learned mnemonic was not context bound, but was context free from studying science vocabulary. This may have allowed these students to transfer the mnemonic method to study contextually dissimilar information (i.e., Revolutionary War battle events). It is possible that students did not associate the learned mnemonic with learning science vocabulary only, but realized that the mnemonic could be used to study all sorts of information.

From an educational perspective, these findings have important implications. It is beneficial for both educators and students, in that when students learn the keyword mnemonic under a specific context (i.e., study science material) they then can use this mnemonic to study different material (i.e., history content).

LIMITATIONS & FUTURE RESEARCH

There was a main limitation to the procedures and analyses of this study. The instructional format (i.e., self-taught) may have affected the effectiveness of the ability of students to learn their respective mnemonic, which in turn may have affected their ability to transfer the use of the mnemonic. Future researchers should design their procedures so that students in each mnemonic condition demonstrate the ability to understand and use their respective mnemonic. For example, instead of using a self-taught booklet, researchers might use direct instruction to teach each mnemonic to a group of students and then set a criterion that qualifies the student as having successfully learned how to use and

apply the mnemonic (e.g., 70% recall or recognition on a test). This may demonstrate that students understand and can use their respective mnemonic, which in turn would give the researchers more accurate measure of transferability.

CONCLUSION

The goals of this study were to investigate the use of the method of loci, pegword, and keyword mnemonics to study eighth-graders' ability to transfer use of these mnemonics under specific and general transfer conditions. As demonstrated by this study, the keyword mnemonic may be successfully used to study different content that is similar and dissimilar to the originally studied information. However, as Scruggs and Mastropieri (1992) suggest, "mnemonic instruction as powerful as it has been shown to be, is not an educational panacea" (p. 228). Therefore, mnemonic instruction should be used to augment other methods of science instruction especially when instructional objectives require the acquisition and retention of science vocabulary and facts.

REFERENCES

Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. *Review of Educational Research, 58*, 375-404.

Atkinson, R. C. (1975). Mnemotechnics in second-language learning. *American Psychologist, 30,* 821.828.

Bellezza, F. S. (1996). Mnemonic methods to enhance storage and retrieval. In E. L. Bjork & R. Bjork (Eds.) *Memory* (pp. 345-380). San Diego, CA: Academic Press.

Bjorklund, D. F. (2000). *Children's thinking: Developmental functional and individual differences.* Belmont, CA: Wadsworth/Thomson Learning.

Bordens, K. A., & Abbot, B. B. (2005). *Research design and methods.* (6th Ed.). Boston, MA: McGraw-Hill.

Brigham, F. J., Scruggs, T. E., & Mastropieri, M. A. (1995). Elaborative maps for enhancing learning of historical information: Uniting spatial, verbal, and imaginal information. *Journal of Special Education, 28*(4), 440-460.

Carney, R. N., & Levin, J. R. (1994). Combining mnemonic strategies to remember who painted what when. *Contemporary Educational Psychology, 19*(3), 323-339.

Carney, R. N., & Levin, J. R. (2000). Mnemonic Instruction, with a focus on transfer. *Journal of Educational Psychology, 92*(4), 783-790.

Carney, R. N., Levin, J. R., & Morrison, C. R. (1988). Mnemonic learning of artists and their paintings. *American Educational Research Journal, 25,* 107-125.

Cormier, S. M., & Hagman, J. D. (1987). *Transfer of learning: Contemporary research and applications*. New York: Academic Press.

Gick, M. L., & Holyoak, K. J. (1987). The cognitive basis of knowledge transfer. In S. M. Cormier & J. D. Hagman (Eds.), *Transfer of learning: Contemporary research and applications.* San Diego, CA: Academic Press.

Gray, W. D., & Orsanu, J. M. (1987). Transfer of cognitive skills. In S. M. Cormier & J. D. Hagman (Eds.), *Transfer of learning: Contemporary research and applications*. San Diego, CA: Academic Press.

Hacker, D. J. (1998). Self-regulated comprehension during normal reading. In D. J. Hacker, J. Dunlosky, & A. C.

Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 165-191). Mahwah, NJ: Erlbaum.

Hale, G. A. (1983). Students' predictions of prose forgetting and effects of study strategies. *Journal of Educational Psychology, 75*, 708-715.

Higbee, K. L. (1977). *Your memory*. Englewood Cliffs, NJ: Prentice-Hall.

Hwang, Y., & Levin, J. R. (2002). Examination of middle-school students' independent use of a complex mnemonic system. *Journal of Experimental Education, 71*(1), 25-38.

Konopak, B. C., & Williams, N. L. (1988). Eighth graders' use of mnemonic imagery in recalling science content information. *Reading Psychology, 9*(3), 233-250.

Levin, J. R. (1981). The mnemonic 80s: Keywords in the classroom. *Educational Psychologist, 16*(2), 65-82.

Levin, J. R. (1993). Mnemonic strategies and classroom learning: A twenty-year report card. *Elementary School Journal, 94*(2), 235-244.

Levin, J. R., Morrison, C. R., McGivern, J. E., Mastropieri, M. A., & Scruggs, T. E. (1986). Mnemonic facilitation of text-embedded science facts. *American Educational Research Journal, 23*(3), 489-506.

Mastropieri, M. A. & Scruggs, T. E. (1998). Constructing more meaningful relationships in the classroom: Mnemonic research into practice. *Learning Disabilities Research & Practice, 13*(3), 138-145.

McLaughlin, C. W., & Thompson, M. (1999). *Physical science: Teacher wraparound edition*. New York: Glencoe/McGraw-Hill.

Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (1997). Meaningful learning in science: The human constructivist perspective. In G. D. Phye (Ed.), *Handbook of academic learning: Construction of knowledge.* San Diego, CA: Academic Press.

Moe, A., & De Beni, R. (2005). Stressing the efficacy of the loci method: Oral presentation and the subject-generation of the loci pathway with expository passages. *Applied Cognitive Psychology, 19*(1), 95-106.

Pressley, M., & Dennis-Rounds, J. (1980). Transfer of a mnemonic keyword strategy at two age levels. *Journal of Educational Psychology, 72*(4), 575-582.

Roediger, H. L. (1980). The effectiveness of four mnemonics in ordering recall. *Journal of Experimental Psychology: Human Learning and Memory, 6*(5), 558-567.

Rummel, N., Levin, J. R., & Woodward, M. M. (2003). Do pictorial mnemonic text-learning aids give students something worth writing about? *Journal of Educational Psychology, 95*(2), 327-334.

Schmidt, R. A., & Bjork, R. A. (1992). New vocabularyualizations of practice: Common principles in three paradigms suggest new vocabulary for training. *Psychological Science, 3*, 207-217.

Schoenfeld, A. H. (1999). Looking toward the 21st century: Challenges of Educational Theory and Practice. *Educational Researcher, 28*(7), 4-14.

Scruggs, T. E., & Mastropieri, M. A. (1992). Classroom applications of mnemonic instruction: Acquisition, maintenance, and generalization. *Exceptional Children, 58*(3), 219-229.

Scruggs, T. E., & Mastropieri, M. A. (2000). The effectiveness of mnemonic instruction for students with learning

and behavior problems: An update and research synthesis. *Journal of Behavioral Education, 10*(2/3), 163-173.

Scruggs, T. E., Mastropieri, M. A., Sullivan, G. S., & Hesser, L. S. (1993). Improving reasoning and recall: The differential effects of elaborative interrogation and mnemonic elaboration. *Learning Disability Quarterly, 16*(3), 233-240.

Toothaker, L. E. (1991). *Multiple comparisons for researchers.* Newbury Park, CA: Sage.

Wang, A. Y., & Thomas, M. H. (2000). Looking for long-term mnemonic effects on serial recall: The legacy of simonides. *American Journal of Psychology, 113*(3), 331-340.

Yates, F. A. (1966). *The art of memory.* London: Routledge & Kegan Paul.

NOTE

This manuscript was accepted as the 2007 Distinguished Paper received in October of 2007 at the annual conference of the Northern Rocky Mountain Educational Research Association.

AUTHORS NOTE

Aaron S. Richmond is an Assistant Professor of Educational Psychology in the Department of Psychology at Metropolitan State College of Denver.

Rhoda Cummings is a Professor of Educational Psychology in the Department of Counseling and Educational Psychology at the University of Nevada-Reno.

Mike Klapp is a Middle School Science teacher at O'Brien Middle School in Stead Nevada.