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The Use of Memory Strategies by College Students

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The Use of Memory Strategies by College Students

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Abstract

The current study examined college students’ use of memory strategies, including type and diversity both within and across disciplines as related to Siegler’s work with young children and their use of multiple and variable strategies. A survey was developed for this study and completed by 147 college students in an undergraduate level human development course. There are four research questions associated with this study: 1) do contemporary theoretical models, such as Siegler’s Adaptive Strategy Choice Model, adequately characterize college students’ strategy use?; 2) are there differences in the frequencies students report using particular strategies within a single discipline and across different disciplines?; 3) what is the relationship between diversity of memory strategy use and final grades for each discipline?; 4) to what extent are individual differences related to students’ use of memory strategies? The study found that students use, on average, 3.52 strategies. Eighty-nine respondents, who reported using strategies for three disciplines, indicated they use rehearsal more in natural science and social science than in mathematics, organization more in natural science than social science and mathematics, elaboration more in natural science and social science than mathematics, and imagery and acronym more in natural science than social science which is also more than mathematics. Results, using from 109 to 133 participants depending on the data provided for each discipline, failed to show a relationship between number of memory strategies used and final grades. Finally, results also failed to show that there were individual differences related to students’ use of memory strategies.
Acknowledgements

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The Use of Memory Strategies by College Students

Remember sitting in an elementary school science class and the teacher asking you to list the colors of the rainbow? One strategy that students use to recall this information is the name Roy G. Biv, an acronym for the colors of the rainbow (red, orange, yellow, green, blue, indigo, and violet). While this acronym might seem rather trivial, it is part of something much larger: memory strategies. Studies have found that the advantages of using memory strategies are not trivial (Roediger, 1980; Greene 1999; Scruggs & Mastropieri, 2000). In this thesis, theoretical perspectives on the use of memory strategies will be presented along with factors that influence their use. Topics that are discussed include: examples of memory strategies, benefits/usefulness of memory strategies, factors that influence their use, obstacles to using them, and theoretical models of using memory strategies.

In higher education course work, college students learn in classroom contexts and outside of the classroom as they read, complete assignments, and study for exams. As they engage in processes related to learning and assessment, students are continuously encoding, storing information in memory, and retrieving, accessing information in memory. Students may use memory strategies to facilitate these processes. McDougall and Gruneberg (2002) found that on a psychology test, college students used a mnemonic strategy 60% of the time. The retrieval cues most often used were names or concepts. Students only used more formal mnemonics like acronyms a small proportion of the time.

This study examined college students’ use of memory strategies, including type and diversity across disciplines, such as mathematics and science. Specifically, the following questions are investigated: 1) do contemporary theoretical models, such as
Siegler’s Adaptive Strategy Choice Model (ASCM, 1996), adequately characterize college students’ strategy use?; 2) are there differences in the frequencies students report using particular strategies within a single discipline and across different disciplines?; 3) what is the relationship between diversity of memory strategy use and final grades for each discipline?; and 4) to what extent are individual differences related to student’s use of memory strategies?

Students’ Use of Memory Strategies

Students use memory strategies at implicit and explicit levels of awareness. At the implicit level, students use memory strategies without necessarily realizing that they are employing strategies (Siegler & Stern, 1998). For example, if asked to list classmates names, rather than telling them in a haphazard method, one may start by listing fellow students into groups or clusters based on seating arrangements, ethnicity, or gender. Listing information in this manner provides organization and helps prevent forgetting someone (Bjorklund & Zeman, 1982; 1983). Using this conceptual organization is a memory strategy.

As students progress through their education, parents, teachers, and others provide explicit instruction in the use of memory strategies, similar to Roy G. Biv. These can be simple acronyms to help us recall facts. An example is HOMES to help list the Great Lakes in the United States (Huron, Ontario, Michigan, Erie, and Superior). Students learn that when memorizing a list of information, it can be very easy to create an acronym to improve retrieval.
Examples of Memory Strategies

Rehearsal, a common method for studying information, involves repeating the material silently until it is memorized. One of the more important studies regarding the rehearsal method was conducted by Flavell, Beach, and Chinsky (1966). In this study, children in kindergarten, second grade, and fifth grade were shown pictures and asked to remember them. After they were shown the pictures, there was a fifteen second delay before they were tested. An observer trained to read lips watched the students’ mouths. The researchers found that the older students used more rehearsal than younger students. They also found that students who used the rehearsal method were able to recall more information. These findings led the researchers to conclude that the use of rehearsal as a memory strategy increases with age and the number of times a student practices the information has a positive impact on memory performance.

Additional research for this memory strategy was conducted by Ornstein, Naus, and Liberty (1976). This study included children in third grade, sixth grade, eighth grade, and ninth grade, and required students to rehearse words. This study found that no matter what their grade level, students used the rehearsal memory strategy. The researchers found that younger students used a passive rehearsal strategy, repeating the words in a series individually. The older students used a cumulative rehearsal strategy, repeating all of the words in a series together. The older students were also more likely to rehearse related together and it also improved recall. Thus, the rehearsal memory strategy is a technique that can help all children recall information, but some forms of rehearsal (i.e., cumulative) benefit recall to a greater extent.
Another memory strategy that has an impact on how people recall information is *imagery*. Imagery can be described as developing a mental picture of what needs to be recalled. A study conducted by Clark and Paivio (1991) showed that the use of imagery when studying can impact performance in several educational domains. An example from American History involves forming an image of George Washington standing up on a rowboat as it crosses a partially frozen river. This might help a student recall that he crossed the Delaware River during the American Revolution.

A further type of memory strategy is *elaboration*. This strategy incorporates two or more items together to represent an image, sentence, or word. For example, an image of a pizza sitting on top of the phone may help a person remember to order a pizza for dinner. Two additional examples of elaboration strategies include the keyword method and the pegword system.

The *keyword method* is a strategy that incorporates the meaning of the word along with a rhyming word and a picture that will help to explain the definition. The statistical term mode – the number with the most frequencies – is used here as an example for implementing the keyword method. A rhyming word for mode is toad, and a picture might include someone walking through a creek surrounded by toads with a caption saying, “As I walked through the creek the most frequent animal I saw was a toad.” This type of mnemonic device provides a great deal of flexibility for information that needs to be retrieved. As shown by this example, the mnemonic device can be rather humorous, which may also help the student to better recall the information.

The *pegword system* is another example of elaboration that uses rhyming strategies for words and associated numbers. The goal is to have the key word rhyme
with the appropriate number. A commonly cited example is, “One is bun, two is shoe, three is tree”. This example refers to a list of words a student needs to memorize, the first word being bun, the second shoe, and the third tree. Having the words rhyme with numbers to maintain the order is useful.

The organization technique has the user categorize objects into groups to assist with recall. A study conducted by Salatas and Flavell (1976) found that students who use organization techniques had better recall. In this study, children in the first grade were divided into two groups: a remember group and a look group. The remember group was instructed to organize as they studied and the look group only looked while they studied. The researchers concluded that students in the remember group were using the organization technique and demonstrated better recall than the look group after six weeks of instruction.

Finally, letter strategies, such as acronyms, are especially useful when studying lists of information. Acronyms are words formed from the initial letters of a series of words. These strategies require the least amount of preparation and provide a great deal of flexibility. A rather common acronym used to recall the letters representing lines for a standard G-Clef is Every Good Boy Does Fine (E, G, B, D, F).

Utility of Memory Strategies

There are several reasons why memory strategies are useful. First, memory strategies can be fun to create. They permit the student to determine a method to retrieve the information that works well for him/her as an individual. Second, the use of memory strategies stimulates the student’s creativity and also works as a form of ownership. Foos, Mora, and Tkacz (1994) found that individuals recall information from materials
they generate better than materials generated by other people for them, referred to as the generation effect (see also Mulligan, 2001). Third, from a cognitive perspective, memory strategies provide several pathways for the student to recall the necessary information. Using the keyword system as an example, there is a visual representation, a rhyming word, a definition and, if read aloud or discussed, an acoustic connection, providing multiple representations to help the student recall the information. Fourth, once learned, memory strategies can be incorporated into a variety of tasks that will occur throughout life. Fifth, memory strategies can provide great benefits for understanding, storing, and retrieving complicated information.

Research also provides evidence that memory strategies greatly improve the test scores of students who indicate their use (Roediger, 1980; Greene 1999; Scruggs & Mastropieri, 2000). Students with learning disabilities have increased scores by more than 35% when they incorporate mnemonic devices into their learning (Mastropieri, Sweda, & Scruggs, 2000). Normally achieving students have also increased their test scores by 5% when they incorporate mnemonic devices (Mastropieri et al., 2000). Thus, mnemonic devices can provide a great benefit for all students.

Factors that Influence the Use of Memory Strategies

A number of factors influence the use of memory strategies. Below, research on knowledge base, metamemory, motivation, individual differences, and automaticity are discussed.

Much research has indicated that an individual’s personal knowledge base, or their background information regarding a specific topic, influences strategy use (Schneider, Korkel, & Weinert, 1989). The more people know, the easier it is to encode
and retrieve information. As people develop their knowledge base, there is more content that they are familiar with, which may provide more nodes to connect information. For example, if a person with a strong history background were to learn something new, it would be easy for them to connect it to something they could easily recall with a historical fact. Another person, who does not have much history knowledge, might have a difficult time because the new piece of information may not be connected easily to other information.

An important study in this field was conducted by Chi (1978) who compared children who were chess experts and adult chess novices’ memory for digits and chessboard configurations. Findings indicated that although adults outperformed children on digit memory, children actually outperformed adults on memory for chessboard configurations. It has been interpreted from this study that there are two types of capacity for memory, *actual capacity*, which does not change and *functional capacity*, which depends on what is being remembered. It was concluded that the children, due to their chess expertise, were using a chunking strategy, facilitated by pattern recognition that led to better recall.

*Metamemory* can be defined as the knowledge a person has regarding the functioning and contents of their memory. In 1975, a study examined how much young children were aware of their memory (Kreutzer, Leonard, & Flavell, 1975). In this study the researchers found that children in kindergarten and first grade were aware that they could forget information in their short-term memory. They also were aware that it is easier to relearn material after forgetting it. Third, they were aware that recall of information was affected by study time, properties of the information, and how many
items needed to be retrieved (see Schneider & Pressley, 1997 for an alternative view).

Finally, they were aware that external memory strategies were useful in retrieving information. The researchers also studied third and fifth graders. They found these children planned their study habits more, were more self-aware of how they approached the problems, and had more procedures to solve the problems.

**Motivation** is also an important factor in determining whether or not students use a memory strategy. VanderStoep, Pintrich, and Fagerlin (1996) studied motivation, knowledge, and self-regulation differences in college students across three disciplines: English, Psychology, and Biology. The general findings of the study include, students with “adaptive motivational beliefs and particularly high efficacy and task value beliefs” (p. 356) reported more use of cognitive and metacognitive strategies. They also indicated that, “personal attributes of high levels of domain-specific knowledge, adaptive motivational beliefs, and use of self-regulatory strategies” (p. 360) describe high achievers for social science and natural science courses. They suggested changes to evaluation techniques for humanities courses because the nature of those courses is different from social and natural science courses. They recognized that humanities courses require students to use strategies their study did not incorporate.

**Individual differences** in psychological and cognitive attributes also influence use of memory strategies. Several studies have found that differences in intelligence, learning disabilities, and knowledge base affect how well students are able to use memory strategies. One particular study looked at the relationship between a student’s goal orientation and his/her use of learning strategies (Somuncuoglu & Yildirim, 1999). The researchers used three orientation subscales – mastery, ego-social, and work
avoidant. The *mastery* subscale measured joy of learning and completion of class assignments as a challenge. A student with mastery orientation would be more likely use deep cognitive and metacognitive strategies and would be less likely to use surface cognitive strategies. The *ego-social* subscale helped identify students who wanted to succeed in class in order to outperform others; their goal would be to do well to impress others. A student with ego-social orientation would be more likely to use surface cognitive strategies rather than deep and metacognitive strategies. The final subscale, *work avoidant*, identified students who did enough so as not to fail; they generally put in as little effort as possible to pass the course. A student with work-avoidant orientation was hypothesized not to be as likely to use deep cognitive and metacognitive strategies. The researchers found that almost all of the students were either mastery oriented or mastery and ego-social oriented. Only a few students were determined to be work avoidant and ego-social.

The *automaticity* of memory strategies is one of the more difficult challenges. It could be said that one of the reasons students do not automatically use memory strategies is that it takes time to learn how to use them. Automaticity was the focus of a study conducted by Payne and Wenger (1996). They state that along with using memory techniques for encoding and retrieval of information, it is necessary to practice the memory technique. It is through practice that an individual is not only able to encode more information, but is also able to more accurately retrieve this information. In addition to being able to encode and retrieve more information, the individual is also able to *speed-up* their encoding abilities. The authors also discuss the importance of practicing the use of memory strategies spread out over time. Previous research on
distributed versus mass practice found learning is improved when it is spread out over
time rather than compressed before testing (Hovland, 1936 and Hall, Smith, Wegener, &
Underwood, 1981). Payne and Wenger conclude the spacing effect is a valuable
encoding variable when improving memory skills. Finally, the authors also argue that it
is important to practice retrieving information. Practicing retrieval improves one’s ability
to recall the practiced item when it is needed. Unfortunately, the authors state, “There is
relatively little evidence to suggest that retrieval practice generalizes to new items or

Obstacles to Using Memory Strategies

Some argue that as students use new strategies, they sometimes experience
difficulty in executing them. Bjorklund and Douglas (1997) describe three types of
deficiencies that occur in children’s strategy use. A mediation deficiency occurs when
the student: a) does not know how to use the memory strategy, b) cannot effectively
execute the memory strategy, and c) sees no benefit in using the memory strategy.
Another type is a production deficiency. This occurs when the student: a) does not think
to use the memory strategy, b) can execute the memory strategy after it is demonstrated,
and c) benefits from using the memory strategy. The third is a utilization deficiency.
This deficiency shows the student: a) can use the memory strategy, b) can effectively
execute the memory strategy, and c) does not benefit from using the memory strategy.

There are a few possible explanations as to why students have a utilization
deficiency and are not using a memory strategy automatically. As students begin using a
new memory strategy, they must simultaneously keep the information they are trying to
learn in their working memory while they are also trying to execute the strategy. Mental
resources are limited, and as students learn a new strategy, their mental assets are focused on developing and using the new strategy comfortably. As students focus their energies, the information that they are trying to learn with the new strategy receives very little mental resources for storage. The result is that the information is often forgotten. As students practice using the new strategy, their mental resources are freed and available for storing the information.

No matter what type of strategy is implemented to study a topic, the most important aspect is that the encoding and retrieval techniques must be well learned and fully adapted by the student in order to be truly effective. Shaughnessy and Reif (1987) found that mnemonic strategies may not always be effective as a personal learning strategy. The researchers found that while older adult students using mnemonic devices were successful, the control group for the experiment demonstrated a superior performance. The researchers believed there were two potential reasons for this occurrence; students in the control group had past effective experience with a learning strategy or the mnemonic device interfered with the learning process. While this might appear as a negative for memory strategies, the work published by Miller, Woody-Ramsay, and Aloise (1991) and Bjorklund and Harnishfeger (1987), as found in Bjorklund and Douglas (1997), indicates that the amount of mental effort required for a student to use a new memory strategy may not provide enough remaining resources to recall the required information.

There are additional impediments with using memory strategies, including that they can be time consuming to create. With the keyword mnemonic system, it is necessary to develop a rhyming word and also think of a situation that can be drawn to
help show the meaning of the word. If a teacher or student is not comfortable with their artistic capabilities, the idea of drawing a picture might make it an impossible task. The pegword system is limited to developing rhyming strategies with numbers. Another difficulty with memory strategies is that they tend to work best for factual information, such as definitions or lists. Often times learning involves more than an ability to recite information. Learning must show understanding of concepts and the impact of those concepts. A mnemonic device cannot necessarily always accomplish that type of learning.

Mnemonic devices are great aides for shallow cognitive processing, but may not lead to long-term retention of information. It should be noted that other memory strategies, like elaboration and organization, that involve deep encoding, provide the opportunity for more long-term memory. A final detractor for memory strategies is that they may be localized only to the immediate test. It is speculated that students tend to only remember information related to the memory strategies for an immediate test. Upon completion of the test, the students may forget the mnemonic, the connection for the information studied, and, as a result, the information studied is lost until the mnemonic is rediscovered, the connection is reactivated via other means, or the information is relearned.

*Theoretical Models of Strategy Use*

There are several theories regarding strategic development in children. Several of these theories use a staircase to help explain growth. Piaget’s theory of intellectual development, presented in Figure 1, provided a *staircase* metaphor for age-related changes in children’s thinking. In 1981, Siegler used a staircase metaphor also to
describe his model of strategy use. Using simple addition as an example, he argued that children aged three to four would add based on the relative length of math bars. Most five-year-olds would count the number of objects in each row, and most six-year-olds would use a transformation to solve the problem (Siegler, 1981). As the children grew older, it was theorized that they would be able to handle a more complicated system to find out the answer.

Figure 1. Piaget's model for cognitive development. Adapted from Siegler (1996).
Siegler (1996), has since modified his views of changes in strategy use, replacing the staircase model with an overlapping waves model of change in strategy use, presented in Figure 2. Research by Siegler (1996) and others (e.g., Coyle & Bjorklund, 1997) conducted mostly on children between the ages of three and thirteen has shown that they will use several different strategies at different ages and that younger children focus on the same strategy(ies) more often. As the children age, they incorporate additional strategies. In this theory, people use several strategies at the same time, something not included in initial models of strategy use.

*Figure 2. Siegler’s overlapping waves model of cognitive development. Adapted from Siegler (1996).*
Siegler found his theory applied to several different domains. For example, with math, children may use recall if the addition problem is simple, they may use backup strategies, such as the min strategy, which includes counting from the larger addend. For example when adding two plus three, the student starts at three and counts four and five to attain the correct answer. Or, they may count with their fingers, if the problem is more complex. His research found that younger children counted their fingers, but several used the min strategy and a few were able to recall the correct answer. As children continued through school, more used the min strategy and recall and fewer students counted their fingers. This trend, of students applying different strategies during the same age to solve problems applied to other domains including multiplication, locomotion, language development, moral development, and social interaction (Siegler, 1996).

Siegler argues that the flexibility of his model better represents the possible strategy use of all children. He uses waves, a more fluid depiction, and not a staircase, a solid description, to indicate that as one strategy increases another one will decrease. This model explains that for children to use different strategies in situations, as they see fit, is normal. Children choose to solve different problems in different ways. This belief led to the development of his strategy-choice model, in which children will try different strategies to solve a problem. As they age, their choice of strategies will alter.

Siegler performed a computer simulation called Adaptive Strategy Choice Model, or ASCM (Siegler, 1996). The initial goal of the simulation was to model the development of single digit addition from four years on. The simulation provided an illustration of how self-modification can generate changes in children’s thinking. One of
the main ideas for ASCM is that cognitive change is created through experience of solving problems. After 1,250 trials, ASCM was studied to determine how well the computer simulation worked. Change in problem solving was evident. As ASCM was provided more opportunities to solve addition problems, it generated correct answers more often, indicating that variability leads to adaptive change.

The Current Study

Siegler’s work described adaptive choices in young children’s strategy use as they learn different types of information, emphasizing children’s use of multiple and variable strategies depending on task difficulty and familiarity. The current study was designed to examine college students, to determine whether or not Siegler’s model describes their strategy use. Specifically, the current study examined college students’ use of memory strategies, including type and diversity within and across disciplines, such as mathematics and science. Currently, it is unclear if Siegler’s model is accurate only for strategic development through childhood, ages three to thirteen, or if it also applies to strategy use across the life span. Participants completed a survey that assesses the extent to which they use various strategies in various disciplines, such as mathematics, natural science, humanities, and their grades in each of these disciplines.

The following questions were investigated.

- First, do contemporary theoretical models, such as Siegler’s Adaptive Strategy Choice Model (ASCM), adequately characterize college students’ strategy use?
  - It was hypothesized that college students will report using multiple memory strategies when they prepare for an exam. This was
indicated in Siegler’s work with young children, it is expected to continue with college students.

- Second, are there differences in the frequencies students report using particular strategies within a single discipline, such as Natural Science, and across different disciplines, such as mathematics and humanities?
  - It was hypothesized that within disciplines, such as science, there will be between-participant variability in reported frequencies of use for particular strategies.
  - Furthermore, it was hypothesized that across disciplines, such as mathematics and humanities, there will be within-participant variability in reported frequencies of use of particular strategies.

- Third, what is the relationship between diversity of memory strategy use and final grades for each discipline?
  - It was hypothesized that students who have a higher number of memory strategies for each discipline will have higher final grades for the corresponding disciplines.

- Fourth, to what extent are individual differences related to student’s use of memory strategies?
  - It was hypothesized that individual differences in variables such as the number of years of college experience and academic standing (freshman, sophomore, junior, and senior) will be related to the number of strategies used in each discipline.
Method

Participants

The participants were 147 college students enrolled in an undergraduate level human development course. Participation was voluntary and students did not receive extra credit for participation. Based on a typical attendance of 165 students, the response rate was 89%. The mean age of the participants was 21.59. Of the students who participated 87.8% were female and 12.2% were male, this large difference in gender was not anticipated. The ethnic composition of the participants included 83.0% Caucasians, 11.6% African-American, and 5.4% were a variety of other ethnic groups. Participants were mostly from two colleges in the University of Cincinnati, 46.3% of the participants indicated enrollment in the College of Nursing, 36.7% indicated enrollment in the College of Education, Criminal Justice, and Human Services, and 17.0% were enrolled in other colleges around the university. There was a variety of responses for academic standing, 6.8% participants indicated they were freshmen, 60.5% were sophomores, 15.6% juniors, 15.0% were seniors and 2.0% were graduate students.

Measurement

Participants were asked to complete a four-page survey presented in Appendix A. The first component of the survey includes 14 demographic questions concerning gender, date of birth, ethnicity, college enrollment for the University of Cincinnati, declared major (with an option for undeclared), declared minor (with an option for undeclared), number of years in college, cumulative grade point average for the University of Cincinnati, class status, an indication of enrollment as either full-time or part-time student, native language, and any physical or learning impairments. Responses to
ethnicity, college enrollment, and class status were used as between subject variables in the analyses for research question four.

The second component of the survey presents five sections, one for each of the following discipline areas: humanities, mathematics, natural science, and history. Human Development - Middle Childhood and Adolescence is also included because it is the second course in a sequence and the survey was distributed during the third course in the sequence before any exams were provided. Within each section, five rows containing different memory strategies are presented: rehearsal, elaboration, imagery, organization, acronym, and a space for another type of memory strategy used. Included in the survey are definitions and examples for each strategy. Participants marked a rating to indicate the frequency of use for each memory strategy using the following five-point Likert Scale: None of the time, A little of the time, Some of the time, Most of the time, and All of the time. The top of each discipline area requests participants to name one course they had taken, the quarter when the class was taken, and the grade they received. The frequency ratings were used as the dependent measure with strategy and discipline as the within-subject factors to answer research question two. Respondents’ ratings for the five memory strategies were converted into dichotomous variables, either using the strategy or not. These variables were tallied to determine the strategy diversity used in research question one and was correlated with final course grades in each of the disciplines for research question three.

Procedure

The experimenter distributed copies of the informed consent form to all individuals who volunteered to participate in the study (see Appendix B). The
experimenter reviewed the consent form out loud, explaining that participation was voluntary and pointing out contact information regarding the study. Then, the experimenter distributed the survey and provided verbal instructions regarding completion (see Appendix A). As students completed the survey, the experimenter was available to address questions and concerns. The average completion time was approximately 15 to 20 minutes. When students completed the survey, they returned it to the experimenter and left the classroom.

Results

Since the survey was created for this particular study, the first set of analysis conducted was the determination of the reliability of the survey using Cronbach’s Alpha. The reliability analysis was conducted using the five memory strategies (rehearsal, elaboration, imagery, organization, and acronym) across the five disciplines included in the study (humanities, mathematics, natural science, history, and human development). Some of the analyses were run using three disciplines due to few respondents who completed all aspects of the survey. Reliabilities were in the moderate range with an overall value of 88.6%. In order to account for a low number of participants who reported having taken humanities, history, and human development courses, these three disciplines were collapsed into one discipline: social science. This was completed after correlation analysis suggested these disciplines were related, combined with the theoretical belief that these disciplines are all branches of social science. Similar compressions were required for the following variables due to small group numbers: ethnicity, college enrollment, and class status. Ethnicity was collapsed into three groups (African-American, Caucasian, and Other). College enrollment was also collapsed into
three groups (College of Education, Criminal Justice, and Human Services, College of Nursing, and Other Colleges at UC). Class status was collapsed into two groups (Lower Division and Upper Division).

The first research question addressed whether or not contemporary theoretical models, such as Siegler’s Adaptive Strategy Choice Model (ASCM), adequately characterize college students’ strategy use. Table 1 provides the means and the standard deviations of the number of memory strategies reported by discipline. Figure 3 provides a graph of the number of strategies used in the different disciplines. As predicted by Siegler’s theory, college students report using multiple strategies for each discipline, with an average of 3.52 strategies overall with a standard deviation of 1.22.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>2.81</td>
<td>1.63</td>
</tr>
<tr>
<td>N = 137</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Science</td>
<td>3.95</td>
<td>1.25</td>
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<td>N = 124</td>
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To answer the second research question, repeated-measures analysis of variance (ANOVA) was used. Students’ frequency ratings were compared for the types of memory strategies (rehearsal, elaboration, imagery, organization, acronym) used within and across the different disciplines (humanities, mathematics, natural science, history, and human development). A five Memory Strategy (rehearsal, elaboration, imagery, organization, acronym) by three Discipline (mathematics, natural science, and social science) design was used, with repeated measures for memory strategies. Simple effects analyses were conducted to compare frequency ratings of the memory strategies within and across disciplines.

The second research question addressed whether or not there are differences in the frequencies students report using particular strategies within a single discipline, such as natural science, and across different disciplines, such as mathematics and social science. 89 participants provided data that was used for this analysis. The analysis on frequency
ratings indicated a main effect for strategy, \( F(3.642, 320.505) = 62.464, p < .001, \ \eta^2 = .415 \) and a significant discipline by strategy interaction, \( F(6.474, 569.736) = 5.137, p < .001, \ \eta^2 = .055 \), with degrees of freedom reflecting the Huynh-Feldt correction. The Huynh-Feldt correction, a complex mathematical formula, provides a more stringent analysis that decreased the degrees of freedom for the variable and increased the value of the error term.

Simple effects analyses were conducted to determine the nature of the interaction. The Bonferroni correction was used to provide a more stringent significance value to control for inflation of Type I error due to multiple comparisons \( (p < .0033) \). Results within discipline are presented in Figure 4. Within mathematics, students were significantly more likely to use rehearsal \( (M = 2.40) \) and organization \( (M = 1.99) \), than elaboration \( (M = 0.099) \), imagery \( (M = 0.75) \), and acronym \( (M = 0.76) \). Within natural science, students were significantly more likely to use rehearsal \( (M = 3.12) \) than all other strategies and were significantly more likely to use organization \( (M = 2.35) \), than elaboration \( (M = 1.73) \), imagery \( (M = 1.90) \), and acronym \( (M = 1.88) \), which were not significantly different in reported use. Within social science, students were significantly more likely to use rehearsal \( (M = 3.03) \) than all other strategies and were significantly more likely to use organization \( (M = 2.04) \), than elaboration \( (M = 1.55) \), imagery \( (M = 1.45) \), and acronym \( (M = 1.47) \), which were not significantly different.
Figure 5 displays the interaction across disciplines. As shown, students used rehearsal significantly more in natural science ($M = 3.12$) and social science ($M = 3.03$) than in mathematics ($M = 2.40$). Organization was used significantly more frequently in natural science ($M = 2.35$) than in social science ($M=2.04$) and mathematics ($M=1.99$). Students used imagery and acronym significantly more frequently in natural science (imagery: $M = 1.9$; acronym: $M = 1.88$) than social science (imagery: $M = 1.45$; acronym: $M = 1.47$). For both disciplines these strategies were used significantly more frequently than mathematics (imagery: $M = 0.75$; acronym: $M = 0.76$). For elaboration, students used this strategy significantly more in natural science ($M = 2.35$) and social science ($M = 2.04$) than mathematics ($M = 1.99$).
The analysis for the third question, what is the relationship between diversity of memory strategy use and final grades for each discipline? was completed using correlations between the number of memory strategies reported and the final grade for the course also reported by the student. Results are reported in Table 2. The difference in population sizes is due to the fact that some students reported they did not take a course in various disciplines. There were no significant correlations, indicating no relationship between the number of memory strategies students reported using and their final grades in the disciplines.
Table 2. Correlations between number of memory strategies and final grades

<table>
<thead>
<tr>
<th></th>
<th>Humanities (n=115)</th>
<th>Mathematics (n=133)</th>
<th>Natural Science (n=124)</th>
<th>History (n=109)</th>
<th>Human Development (n=124)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>-.051</td>
<td>-.015</td>
<td>.100</td>
<td>-.061</td>
<td>.028</td>
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</tbody>
</table>

The analysis for the fourth question, to what extent are individual differences related to student’s use of memory strategies, was completed using a series of repeated measures ANOVA with each analysis using ethnicity, college enrollment, and class status as between-subjects factors and frequency of use ratings for each of the five strategies in each of the three disciplines as the within-subjects factors. There was one significant main effect for college with nursing students reporting lower frequency ratings (m = 1.65) than students in the College of Education, Criminal Justice, and Human Development (m = 2.07) and the students enrolled in other colleges (m = 1.95), $F(2, 86) = 3.214, p<.05$, $\eta^2 = .070$. The results provided no other significant main effects or interactions between demographic variables and frequency ratings of strategies both within and across disciplines.

Discussion

The study examined college student’s use of memory strategies including type and diversity within and across disciplines. Participants completed a survey to assess the
extent to which they use various strategies (rehearsal, elaboration, imagery, organization, and acronym) in various disciplines (mathematics, natural science, and social science).

Early work completed by Siegler followed Piaget’s theory of intellectual development, and depicted strategy use as stage like. In 1996, Siegler popularized the idea that children use multiple and variable strategies. Until now, the majority of research investigating Siegler’s model has been conducted on children between the ages of three to thirteen (e.g., Siegler, 1996; Coyle & Bjorklund, 1997). However, it is unclear whether multiple and variable strategy use is a characteristic of the developmental period or of strategy use across the life span. The current study is one of the first to examine this issue in college students. Therefore, the first research question addressed: Do contemporary theoretical models, such as Siegler’s Adaptive Strategy Choice Model (ASCM), adequately characterize college students’ strategy use? The results indicate that students reported using more than three strategies across the disciplines of mathematics, natural science, and social science. This is consistent with the finding of Coyle and Bjorklund (1997), who found children from second grade until fourth grade used up to four strategies. These results indicate that Seigler’s Adaptive Strategy Choice Model does adequately characterize college students’ strategy use. These results further indicate, based on self-report, that college students can and do use different strategies as they prepare for exams. This ability to use multiple memory strategies can be beneficial for students because they are able to use several ways to study the information to fit their needs. This increased flexibility may help students better prepare for their exams and develop memory strategies that work well for them as an individual.
Siegler’s model also predicts that students will use multiple strategies within and across domains. Therefore, the current study asked students to rate the frequency of using various strategies in order to answer the second research question: Are there differences in the frequencies students report using particular strategies within a single discipline and across different disciplines?

The significant interaction between strategy and discipline indicates that there are differences in the frequencies students report using particular strategies both within a single discipline and across different disciplines. However, the low partial eta squared score for this interaction indicates that the finding may not be “practically” significant (Cohen, 1977). Yet, closer examination of the interaction revealed interesting findings regarding patterns of strategy use within and across disciplines. Within disciplines—students used rehearsal and organization to a greater extent than other strategies (elaboration, imagery, and acronym). This is consistent with the findings of Coyle and Bjorklund (1997) and their research with children. Across disciplines, students were more likely to use strategies more frequently in natural science and social science than mathematics.

This provides a great deal of insight into how often students incorporate different memory strategies as they prepare for exams in different disciplines. Students reported using rehearsal and organization with greater frequency. This is particularly interesting because rehearsal tends to be more useful for shallow cognitive processing and the long-term retention is unknown. While organization, as a memory strategy, tends to lead towards deeper cognitive processing and encodes information based on the learners’ knowledge base and conceptual level categories. These combine together and the learner
is more likely to benefit from long-term retention. It is speculated that students are creating a balance between combining short-term goals, passing the test and using the rehearsal memory strategy, with long-term goals of incorporating new learning into existing knowledge base, using the organization memory strategy. A study conducted by Hock, Park, and Bjorklund (1998) found that the use of multiple strategies lead to longer-term retention. Coyle and Bjorklund (1997), also found that children combine strategies in ways that promote retention.

It is interesting that students did not report using the acronym memory strategy with the same frequency as either rehearsal or organization. The acronym memory strategy is very flexible and does not require a great deal of imagination, while helping to encode and retrieve new information. The lower frequency use of the elaboration and imagery memory strategies may be related to the fact that students do not think to use them (i.e., demonstrate a production deficiency) or they may not have had much success using them in the past (i.e., demonstrate a utilization deficiency) and as a result failed to incorporate these strategies into their repertoire. Or it may be related to the fact that these memory strategies require more creativity, effort, and time that college students are not able to provide.

It is interesting to see that students reported using various memory strategies more frequently in both natural science and social science than mathematics. This may be attributed to the fact that these two disciplines lend themselves to the use of different memory strategies. For example, the elaboration memory strategy, a study technique that associates two or more items, using one item to help remember the other item, can work quite well when studying history because there are many ways to connect information.
Yet this memory strategy could be more difficult to use when studying Calculus because the discipline requires a great deal of emphasis on knowledge of formulas. Several students noted on their survey that they often study for their mathematics class by completing practice problems. This may be left over from their time in high school where completing homework problems is the norm.

It is important for educators to know if diversity in strategy use benefits learning as reflected by final grades in the current study. Therefore, the third research question addressed: What is the relationship between diversity of memory strategy use and final grades for each discipline?

It was hypothesized that students who indicated using more memory strategies would also indicate a higher grade for the course. The low correlation values indicate that the number of memory strategies used does not have much impact on the final grades. While this does not follow the hypothesis, it may be explained by students having figured out how one or two memory strategies that work best for them and use them effectively.

This is different from what Seigler found in his work that showed an increase in memory strategies also correlates with an increase in problem solving ability, accuracy, speed and automaticity. It could be that by the time the students are at the college level, they have developed compensation techniques so there is less dependence on the number of memory strategies and more on actually recalling the necessary information.

The differences in results from this study and the work conducted by Siegler could also be attributed to several other factors. Seigler used a performance-based measure of strategy use and an outcome score while his participants were being
monitored. This provides a great deal more precision for testing hypotheses. A second reason could be related to college students not being aware that they are using a strategy. A third explanation, is that the final grade for a college course does not provide much variability, several students could end up with the same grade but have a range of performance, the result is less precision. Finally, while students were asked to rate their strategy use for studying for their most recent exam, the correlation was computed the final grade for the course, which is related to many outside factors not taken into account with this study, which could include grade inflation, motivation of the student, and attendance.

In an effort to determine if there were differences in the frequency of strategy use based on different demographics the fourth research question was asked: To what extent are individual differences related to students’ use of memory strategies?

The comparisons using ethnicity, college, and academic standing as between-subjects variables did not produce any significant main effects or interactions, which is refreshing because it shows that students across ethnic groups, colleges, and academic standing are not using a significantly different frequency of strategies across disciplines. An alternative reason could be based on the fact the measure used in the current study was not sensitive enough to detect group differences, or that differences were canceled out because the focus of the study was on examining averages.

There were several limitations to this study. To begin with it is based on a single survey with 147 respondents that really were not very diverse. Also all the data collected were based on student self-report. Since no personal identifying data was collected, like name or social security number, it was not possible to determine the accuracy of the final
grades reported. Another limitation is that this study asked students to rate the frequency of strategy use in preparing for an exam, but the relationship with the final grade for the course could be predicted by study habits other than just preparing for an exam. Furthermore, the order in which students rated the strategies was not varied through the use of alternative forms. A series of forms with the list of strategies varied may have altered participants’ frequency ratings. Finally, participants may have experienced difficulty in comprehending and recalling the strategy definitions as they completed the survey. For these reasons, it is not encouraged for the results of this study to be widely applied to all college students.

Future Research

Additional studies are recommended for this area to determine if the statistically significant results are also “practically” significant. One way to accomplish this is to distribute the survey in a class with a larger student population. Another way would be to find a series of classes with a better cross-section of students attending the University of Cincinnati and provide a treatment to determine if the broader use of memory strategies really does impact grades for classes. One possibility would be to study four college math courses, two designed for math majors and two designed for non-math majors. One class of each pair would receive a treatment incorporating the use of memory strategies. Additional improvements would be to incorporate interviews or performance based measures to determine if the strategies the participants indicate on the survey is what are really used. Finally, much of the information regarding grades and courses taken across disciplines was based on participant self-report. Future studies could incorporate a method to verify the accuracy of the courses and grades received.
Implications of this study

This study provides some insight into how college students use memory strategies in different disciplines. Future studies should consider the following questions: 1) do universities need to teach incoming freshman a variety of study strategies or is this something that should be accomplished throughout the education process?; 2) do specific disciplines, such as Mathematics, need emphasis in developing lesson plans that incorporate more memory strategies?; 3) will educators at all levels be willing to incorporate the use of different memory strategies into their lesson plans?; and 4) are there specific strategies that benefit learning?

Within the University of Cincinnati, there is an interest in conducting classes that focus on teaching memory strategies; the research conducted here could be very beneficial in these discussions. The research provides a great deal of insight for both the creation of this course. The results that favor the creation of such a course indicate what memory strategies are being used and which ones need emphasis in the class, along with which disciplines need the most help in designing memory strategies for them. However, there was no significant correlation found between strategy use and final grades in the current study. By having educators begin to focus some of their lesson plans on how to study the information, there may be an increase in student interest with the material. This increased interest could lead to higher scores with exams and longer retention of the material. As educators incorporate “how to study” into their lesson plans, they need to remember to use several types of memory strategies. Another aspect is that several people, outside of this study, indicated that they did not recall anyone teaching them how to learn. They do remember many instructors telling them what to learn, but not how to
go about studying the material. This seems rather counterintuitive to the education process. If education is to be the great equalizer in society, wouldn’t it be a good idea to focus time on how to learn?
References


Appendix A
Start Here

1. Gender:  
   - Female  
   - Male

2. Date of Birth: ____________________

3. Ethnicity:
   - African-American  
   - Asian-American  
   - Caucasian  
   - Latino/Hispanic  
   - Multi-Racial  
   - Pacific Islander  
   - Native American (including American Indian, Eskimo, Aleut)  
   - Other (please indicate): ____________________

4. College:
   - College of Allied Health Sciences  
   - College of Applied Science  
   - College of Business Administration  
   - College of Arts and Sciences  
   - McMicken College  
   - Clermont College  
   - College of Conservatory of Music  
   - College of Engineering  
   - College of Nursing  
   - College of Pharmacy  
   - Raymond Walters College of Social Work  
   - School of Social Work  
   - University College  
   - College of Design, Architecture, Art, and Planning  
   - Other (please indicate): ____________________

5. Official Declared Major: ____________________
   - Check if undeclared.

6. Official Declared Minor: ____________________
   - Check if undeclared.

7. Number of years at the University of Cincinnati: ______________

8. Number of years at another college or university: ______________

9. Total number of years in college: ______________

10. Cumulative University of Cincinnati grade point average: ______________

11. Academic standing:
   - Freshman  
   - Sophomore  
   - Junior  
   - Senior  
   - Other (please indicate): ____________________

12. Part-time student  
    Full-time student  

13. What native language do you speak?
   - English  
   - Spanish  
   - Other (please indicate): ____________________

14. Do you experience any of the following: visual impairment, deafness, hearing impairment, physical impairment, learning disability, or a communication disorder?
   - Yes  
   - No

If yes please describe: ____________________
There are several possible studying techniques. Some of the more popular ones are Rehearsal, Elaboration, Imagery, Organization, and Acronyms. To help you understand each of the studying techniques a definition and example are provided.

Rehearsal – a study technique that incorporates repeating information to yourself until it is memorized. For example, reciting a Shakespearean passage until it is memorized.

Elaboration – a study technique that associates 2 or more items, using one item to help remember the other item. For example, drawing a picture of a cat and a gate to remember the Spanish word for cat as gato.

Imagery – a study technique that incorporates a mental picture of what you are trying to remember. For example, developing a mental picture of a human skeleton to remember the location and names of bones.

Organization – a study technique that organizes different items into categories, themes, or other units. For example, creating an outline, diagram, or flow chart to study American History.

Acronyms – a study technique that takes the first letter of keywords to form a new word or phrase. For example, using HOMES to remember the Great Lakes (Huron, Ontario, Michigan, Erie, and Superior)

Please check the frequency you use these study techniques as you prepare for an exam in each of the topic areas. The topic areas are Humanities, Mathematics, Natural Science, History, and Human Development.

**Humanities** i.e. African-American Studies, Literature, Women's Studies, Fine Arts, Foreign Language, Communications

Think of the most RECENTLY COMPLETED humanities course you have taken as you complete this section.

☐ I have not taken a college course in this area.

Write the name of course taken (i.e. Writings by Women) ________________________________

Grade received for this class (i.e. B+): _______  Quarter course taken (i.e. Autumn 2002): ___________________________

Identify the frequency in which you used this study technique

<table>
<thead>
<tr>
<th>Rehearsal</th>
<th>None of the time</th>
<th>A little of the time</th>
<th>Some of the time</th>
<th>Most of the time</th>
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</tbody>
</table>
**Mathematics** i.e. Algebra, Pre-Calculus, Calculus

Think of the most RECENTLY COMPLETED mathematics course you have taken as you complete this section.

☐ I have not taken a college course in this area.

Write the name of course taken (i.e. Finite Math and Calculus) ________________________________

Grade received for this class (i.e. Br): _______  Quarter course taken (i.e. Autumn 2002): ______________________

Identify the frequency in which you used this study technique

<table>
<thead>
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<th></th>
<th>None of the time</th>
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<td>List other strategy used:</td>
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</table>

**Natural Science** i.e. Biology, Chemistry, Geology, Physics, Computer Science

Think of the most RECENTLY COMPLETED natural science course you have taken as you complete this section.

☐ I have not taken a college course in this area.

Write the name of course taken (i.e. Introduction to Geology) ________________________________

Grade received for this class (i.e. Br): _______  Quarter course taken (i.e. Autumn 2002): ______________________

Identify the frequency in which you used this study technique

<table>
<thead>
<tr>
<th></th>
<th>None of the time</th>
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</tbody>
</table>
**History**

Think of the most **RECENTLY COMPLETED** history course you have taken as you complete this section.

- [ ] I have not taken a college course in this area.

Write the name of course taken (i.e. American History 1820-1920)

Grade received for this class (i.e. B+): _______ Quarter course taken (i.e. Autumn 2002): ___________________

Identify the frequency in which you used this study technique

<table>
<thead>
<tr>
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<th>None of the time</th>
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**Human Development – Middle Childhood and Adolescence**

- [ ] I have not taken this college course.

Grade received for this class (i.e. B+): _______ Quarter course taken (i.e. Autumn 2002): ___________________

Identify the frequency in which you used this study technique

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<td>List other strategy used:</td>
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Thank you for your input. Your responses will help us better understand how college students study and prepare for their exams.
Appendix B
Title of Study
Memory Strategies of College Students

Introduction
Before agreeing to participate in this study, it is important that the following explanation of the proposed procedures be read and understood. It describes the purpose, procedures, risks, and benefits of the study. It also describes the right to withdraw from the study at any time. It is important to understand that no guarantee or assurance can be made as to the results of the study.

Purpose
The purpose of this study is to gain information about different learning strategies students use to prepare for exams. You will be one of approximately 150 participants taking part in this study.

Duration
Your participation in this study will last for approximately 20 minutes.

Procedures
I will complete a questionnaire about memory strategies I use as I prepare for an exam. I understand completing this survey should take no more than 20 minutes to complete. I understand that the responses I give will be kept confidential. The only individuals who will have access to the data collected as part of this study are David Sacks and Dr. Brown. Throughout the course of the study, data will be secured in a locked storage area. After the completion of the study, all questionnaires will be destroyed.

Risks/Discomforts
It is not expected that I will experience either risks nor discomfort while completing the survey.

Benefits
You will receive no direct benefit from your participation in this study, but your participation may help professors better understand your study habits.

Right to refuse or withdraw
Your participation is voluntary and you may refuse to participate, or may discontinue participation AT ANY TIME, without penalty or loss of benefits to which you are otherwise entitled. The investigator has the right to withdraw you from the study AT ANY TIME. Your withdrawal from the study may be for reasons related solely to you (for example, not following study-related directions from the investigator, etc.) or because the entire study has been terminated.

If you have any other questions about this study, you may call David Sacks at 556-6615 or Rhonna Brown, Ph.D. at 556-3622. If you have any questions about your rights as a research participant, you may call Dr. Margaret Miller, Chair of the Institutional Review Board – Social and Behavioral Sciences at 513-558-5784.

BY COMPLETING THIS QUESTIONNAIRE, I INDICATE MY CONSENT TO PARTICIPATE IN THE STUDY.