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An Investigation of the SOAR Study Method

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Many believe that college students should be expert learners; after all, they have practiced learning for a dozen or more years. In reality, 73% of college students report difficulties preparing for exams, and this percentage of reported study problems is consistent across college years (Rachal, Daigle, & Rachal, 2007). Research also confirms that college students employ weak strategies in the classroom and while studying (Gubbels, 1999; Kiewra, 1991; Pressley, Yokoi, Van Meter, Van Etten, & Freebern, 1997). Those weak strategies include poor note taking, organizing ideas linearly, learning in a piecemeal fashion, and employing redundant strategies.

Students possess poor note-taking skills when learning from a lecture or text. Lecture note takers omit about 70% of critical lecture points (Kiewra, 1985b, 1985d); text note takers omit about 70% of critical text points as well (Kiewra, DuBois, Christensen, Kim, & Lindberg, 1989). Incomplete note taking is a problem because the number of points recorded in notes is positively correlated with achievement (Baker & Lombardi, 1985; Kiewra, 1984a, 1984b; Kiewra & Benton, 1988; Kiewra, Benton, & Lewis, 1987). Moreover, information omitted from notes has just a 5% chance of later recall (Howe, 1970). Figure 1 provides a concrete example of incomplete and complete notes from a lesson on the planets. The incomplete notes, shown in the summary

Students are rarely taught how to study. When strategy instruction occurs, weak strategies are often advocated or strategies are presented in a hodgepodge, leaving students without a systematic study plan. Students' weak study strategies include recording sketchy notes, organizing ideas linearly, learning in a piecemeal fashion, and employing redundant strategies. SOAR is an integrated study plan that includes the components of *S*election, *O*rganization, *A*ssociation, and *R*egulation. Each SOAR component targets one of the aforementioned weak study strategies commonly used by students. In this experiment, college students read a text about wildcats and then studied provided materials using their preferred study method, the integrated SOAR method, or parts of the SOAR method in preparation for fact and relationship tests. Results confirmed that for relationship learning, the integrated SOAR study method was superior to preferred study methods or using parts of the SOAR method. For fact learning, the combination of Selection and Organization proved best. Association and Regulation processes were ineffective, perhaps because of divided attention or cognitive load. Overall, SOAR showed promise as an integrated study system that is easy to learn, easy to use, and effective.

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Incomplete Notes	Complete Notes
Mercury	Mercury
36 million miles	36 million miles from sun
30 orbital speed	3 months revolution time
3,000 miles diameter	orbital speed 30 miles/sec
rocky	3,000 miles diameter
	rocky surface
Venus	Venus
67 million	67 million miles from sun
8 months revolution	revolution time 8 months
speed 22	22 orbital speed
8,000 diameter	8,000 miles diameter
rocky	rocky surface

***Figure 1*. Incomplete and complete notes for the first two planets.**

figure's left side, omit critical lesson points, such as Mercury's revolution time, and subjugate noted points, such as Venus's surface composition. The brief and confusing note "rocky" might not cue reviewers later to the planet's surface features.

Many students also have difficulty organizing information. Sixty-one percent report having trouble organizing ideas and 52% admit that their notes are disorganized (Rachal et al., 2007). Students commonly organize information linearly in lists or outlines (Gubbels, 1999), and linear organization restricts learning, particularly relational learning (Kiewra, Kauffman, Robinson, DuBois, & Staley, 1999; Robinson & Kiewra, 1995). For example, students studying the linear notes on planets in Figure 2 would have trouble making planet comparisons. For instance, it is difficult to compare information about the planets' orbital speeds because that information appears in eight different places in the linear notes. To determine if there is a relationship between revolution time and orbital speed, the learner must locate and synthesize facts from 16 different places in the linear notes.

Another poor study strategy that students engage in is piecemeal learning—learning one idea at a time rather than

Planets

Inner Planets

Mercury

Miles from the Sun: 36 million
Revolution Time: 3 months
Orbital Speed: 30 miles per second
Diameter: 3,000 Miles
Surface: Rocky

Venus

Miles from the Sun: 67 million
Revolution Time: 8 months
Orbital Speed: 22 miles per second
Diameter: 8,000 Miles
Surface: Rocky

***Figure 2.* Outline for the first two planets.**

integrating common ideas (Bausch & Becker, 2001; Gubbels, 1999). As an analogy of the piecemeal problem, imagine trying to determine the end product of a jigsaw puzzle by examining each puzzle piece separately in turn. "This one is blue with amber shading. This one is rust colored and has a straight edge. . . ." A piecemeal approach does not work for puzzle assembly or for learning assorted details. Yet, students studying the planet information are likely to study it one piece at a time: "Mercury is 36 million miles from the sun. Venus revolves around the sun in 8 months. . . ."

Students also employ a host of redundant strategies, such as rereading and recopying notes, meant to expose them to information again and again. One study reported that two thirds of students study for tests by simply rereading their notes, with more than half of them only doing so minutes before the test (Bausch & Becker, 2001). Another study found that when students study class notes, 12% do nothing more than recopy notes verbatim (Gubbels, 1999). About 50% of students review notes with most passively reciting noted ideas over and over and word for word (Gubbels, 1999). Redundant strategies do not work (Anderson, 1995; Craik & Watkins, 1973), and yet, students studying the planet material are likely to rehearse isolated pieces of information again and again: "Mercury is 36 million miles from the sun. Mercury is 36 million miles from the sun. . . ."

To make matters worse, students have carried these same four weak strategies forward as they transitioned from lecture and text-based learning to computer-based learning (Jairam, 2009). College students reported using weak study strategies such as highlighting, organizing information into lists or outlines, focusing on learning one fact at a time, and redundant strategies like rereading and recopying when learning from computer-based materials.

Weak strategies have two likely origins. First, students are rarely taught how to learn (Durkin, 1979; Zimmerman, Bonner, & Kovach, 1996). Instructors teach content like math and science but often skip the processes needed to learn such content. Instructors tell students to study but rarely say how to do it. Just 20% of teachers believe that teaching students study skills is a priority (James, 2006), and just 17% of college students report that their teachers help them learn or improve study skills (Saenz & Barrera, 2007). Second, students seeking learning assistance are sometimes led astray. Some study skills books (e.g., Ellis, 1997) advocate popular practices like selective note taking, outlining, and rehearsal even though these practices lack empirical support. In other cases, strategies are presented in a piecemeal fashion (e.g., Feldman, 2007). Students are often given a list of plausible study tips but no systematic study plan, or in other cases, students are taught a systematic study plan, but the plan is difficult to implement and is not effective.

The most popular and well-researched study plan, to date, is the SQ3R method developed by Robinson (1941, 1946). The SQ3R acronym stands for *S*urvey, *Q*uestion, *R*ead, *R*ecite, and *R*eview. Although the systematic SQ3R plan can be used time and again for text learning, researchers have found the plan difficult to implement and relatively ineffective. Spor and Schneider (1999) found that nearly 60% of teachers have no knowledge of SQ3R and that only 17% of instructors who reported know-ing the method well actually use it in their teaching. SQ3R is a complex set of strategies that requires intensive and lengthy instruction (Feldt, Byrne, & Bral, 1996; Flippo & Caverly, 2000). No performance improvements were found for students using SQ3R, even when students completed 10 or more hours of SQ3R instruction (Flippo & Caverly, 2000). Other empirical tests of SQ3R also revealed that using the SQ3R system is no better than using single strategies or one's preferred methods. McCormick and Cooper (1991) compared SQ3R to simply reading text and found no achievement differences between groups. Willmore (1966) found that students who underlined their text actually recalled more textbook information than students who used SQ3R. And some researchers (Butler, 1983; Niple, 1968; Scappaticci, 1977) found that students using their own preferred study methods learned just as much as students using SQ3R.

Research shows that students need study strategy remediation and that the remediation needs to be easy to learn and effective. One system that has great promise is SOAR, a system introduced by Kiewra (2005). The SOAR method is comprised of empirically validated learning strategies that activate integral cognitive processes (i.e., attention, encoding, storage, and retrieval).

The SOAR Study Method

SOAR (Kiewra, 2005, 2009) is an acronym for the plan's four steps: *S*election, *O*rganization, *A*ssociation, and *R*egulation. SOAR components are a remedy for the weak strategies, described above, that students commonly employ. Table 1 shows presumed ineffective and effective strategies relative to each SOAR component. Each SOAR component targets one of the common study strategy errors committed by students. The following sections describe the empirical and theoretical support for the SOAR components.

Table 1

Ineffective and Effective SOAR Strategies

SOAR Activities	Ineffective	Effective
Selection	Incomplete Note Taking	Complete Note Taking
Organization	Construct Linear Notes	Construct Graphic Organizers
Association	Piecemeal Learning	Build Associations
Regulation	Redundant Strategies	Self-Test

Empirical Support for the SOAR Components

During the selection component, students who employ ineffective strategies select and record incomplete lesson information; students who employ effective strategies select and record complete notes like those for the planets lesson on the right side of Figure 1. Note taking is positively correlated with test and course performance (Kiewra, 1983; Kiewra & Benton, 1988), and note taking serves both process and product functions. The process of recording notes boosts attention during the lesson compared to simply listening to or reading the lesson without note taking (Kiewra, 1987, 1988). The note-taking product, the set of notes derived, is crucial for review; students who review notes outperform students who do not review notes (Kiewra, 1985a; Kiewra et al., 1991).

The review of notes is crucial for learning, but there exists some debate as to whether students benefit more from studying their own notes or notes provided by the instructor. The advantage of personal notes is that they contain more familiar retrieval cues than the instructor's notes (Van Meter, Yokoi, & Pressley, 1994). The disadvantage of personal notes is that they are often woefully incomplete (Baker & Lombardi, 1985; Kiewra, 1985b, 1985d) compared to the instructor's notes. Note quantity is important; research confirms that the more notes students have available for study, the higher their achievement (Baker & Lombardi, 1985; Kiewra, 1984a, 1984b, 1985c; Kiewra et al., 1987). Moreover, studies that directly compare the achievement of students who review their own notes or those provided by the instructor overwhelmingly favor the latter (Collingwood & Hughes, 1978; Kiewra, 1985b, 1985d; Morgan, Lilley, & Boreham, 1988). A complete set of instructor-provided notes was used in the present study so that the selection component was maximized.

During the organization component, students who employ ineffective strategies organize information linearly in lists or outlines; students who employ effective strategies construct graphic organizers such as hierarchies, sequences, and matrices that showcase relationships among the noted ideas (Kiewra, 1989, 1994). Figure 3 shows a matrix organizer for the planet material. The matrix localizes related information better than the outline in Figure 2 (Kauffman & Kiewra, in press). Whereas the outline separates planets' orbital speed information over eight locations, the matrix organizes those for easy comparison in a single row. Whereas the outline separates revolution time and orbital speed over 16 locations, the matrix organizes those for easy comparison across two matrix rows. Research confirms that students learn more facts and relationships from matrices than outlines when both organizers contain identical information (Kauffman & Kiewra, in press; Kiewra et al., 1999; Robinson & Kiewra, 1995). In the present study, the organization component was a provided set of matrix notes.

During the association component, students who employ ineffective strategies learn in a piecemeal fashion, one idea at a time; students who employ effective strategies build associations that reveal important relationships among ideas. Returning to the planet matrix in Figure 3, the following associations are evident at a glance:

- As planets move further from the sun, revolution time increases.
- As planets move further from the sun, orbital speed decreases.
- Inner planets are smaller than outer planets.
- Inner planets have rocky surfaces; outer planets have slushy surfaces.

	Planets							
	Inner				Outer			
	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Miles From the Sun:	36 million	67 million	93 million	142 million	483 million	886 million	2 billion	3 billion
Revolution Time:	3 months	8 months	1 year	2 years	12 years	30 years	84 years	165 years
Orbital Speed (miles/second):	30	22	19	15	8	6	4	3
Diameter (miles):	3,000	8,000	8,000	4,000	89,000	75,000	32,000	31,000
Surface:	Rocky	Rocky	Rocky	Rocky	Slushy	Slushy	Slushy	Slushy

***Figure 3*. Planet matrix.**

According to Mayer (1984), associations can be internal, like the planet ones above, and show relationships among presented facts; associations can also be external and show relationships between presented facts and prior knowledge. Learning by association is a hallmark principle of educational psychology and is referenced under varying names such as generative learning (Wittrock, 1990), elaboration (Anderson, 1995), and integration (Mayer, 1996a, 1996b). Despite the varying titles, findings uniformly show that associative activities like summarizing (Hidi & Anderson, 1986; King, 1992), asking elaborative questions (Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987), constructing analogies (Clement et al., 1987), linking information to a familiar problem or model (Bransford, Brown, & Cocking, 2000), and using associative mnemonics (Atkinson et al., 1999; Atkinson & Raugh, 1975) improve learning over piecemeal techniques. In the present study, the association component was a list of internal associations.

During the regulation component, students who employ ineffective strategies use redundant activities such as rehearsal; students who employ effective strategies monitor their understanding through self-testing. Here are some practice questions students might generate prior to a test over the planet material:

- How far is Earth from the sun?
- What planet is the largest?
- What planet has the fastest orbital speed?
- What is the relationship between planet size and surface?

Effective students monitor and assess their understanding—know whether or not they know—before their learning is assessed formally, and one effective means of self-regulation is self-testing (Zimmerman et al., 1996). Frase and Schwartz (1975) found that college students who generated practice test questions recalled more information than those who reviewed the material without generating questions. In two studies, King (1989, 1991) found that students prompted to generate questions demonstrated greater lecture learning than unprompted students studying in groups or independently. In the present study, the regulation component was a list of practice questions with answers.

Theoretical Support for the SOAR Components

The SOAR study system has its theoretical roots in the cognitive depiction of the human information processing system. The boxes in Figure 4 represent the three components of the information processing system: sensory memory, short-term memory, and long-term memory. The shaded arrows in the figure represent the cognitive processes learners engage in as they process information. The attention process moves information from sensory to short-term memory, storage and encoding processes move information into long-term memory, and the retrieval process returns information to short-term memory where it is accessible.

Adjacent to the cognitive processes in Figure 4 are the corresponding SOAR components. Each is associated with one of the cognitive processes. The select component is linked to attention because the attention process determines what information is selected for further study (Sternberg, 1985). The organization component is linked to storage because economical storage in long-term memory depends on organizing information categorically (Bruning, Schraw, Norby, & Ronning, 2004; Mayer, 1997). The association component is linked to encoding because research confirms that encoding depends on building associative links in memory (Mayer, 1996a, 1996b). The regulation component is linked to retrieval because research confirms that regulation done through questioning is an effective means to spur retrieval (Frase & Schwartz, 1975; Gettinger & Seibert, 2002; King, 1989).

Summary, Purpose, and Predications

Most college students are inadequate learners. They tend to: (a) record incomplete notes and select just a one third of critical text or lecture points, (b) organize information in a linear

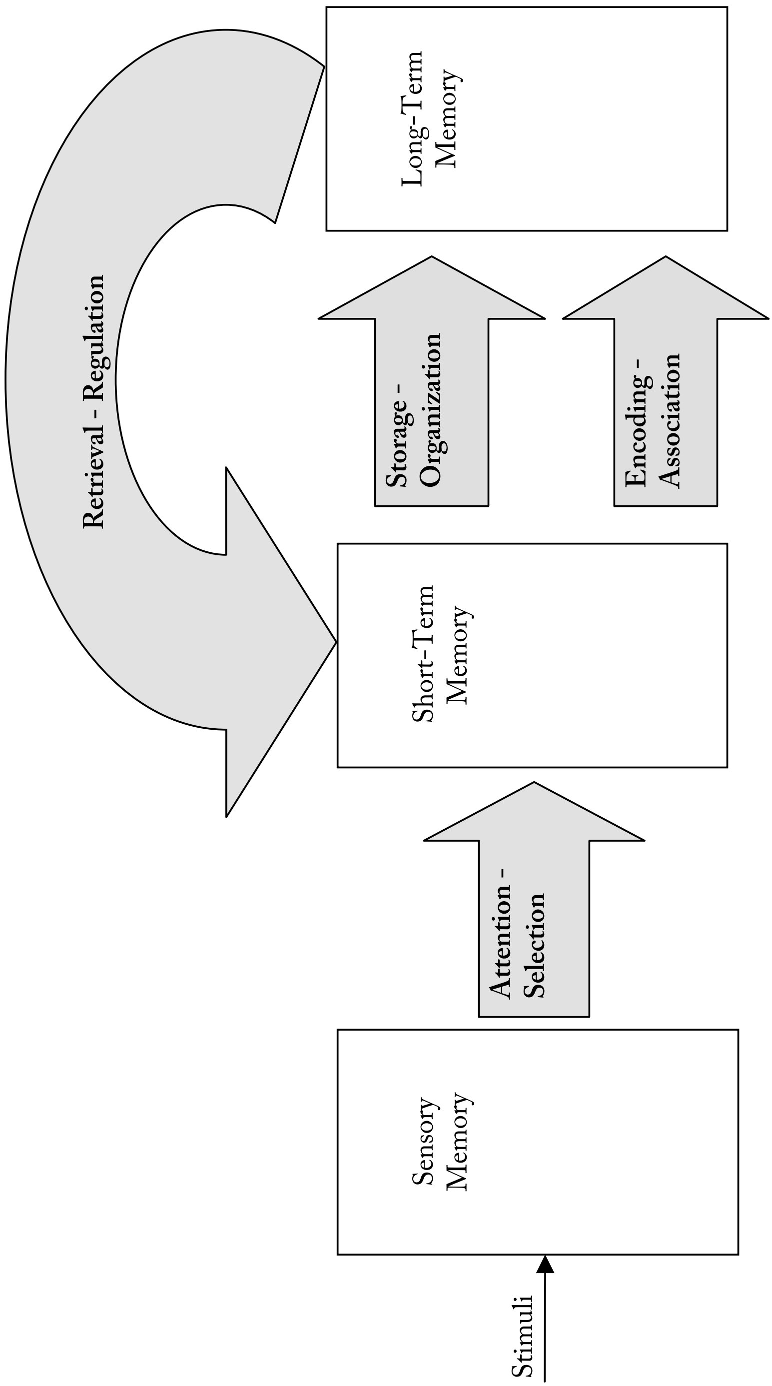

***Figure 4*. Information processing and the SOAR components.**

form using outlines or lists, (c) study isolated facts one at a time, and (d) employ redundant strategies like rereading, recopying, and rehearsal (Aharony, 2006; Biggs, 1993; Kiewra, 2002; Lynch, 2007). As a result, most college students (73%) report difficulty in remembering information for tests (Rachal et al., 2007). Educators have tried to repair weak strategies and boost achievement by teaching students single strategies (Feldman, 2007) or by teaching them the integrated SQ3R study system. Unfortunately, the SQ3R method has proved ineffective relative to the use of single strategies or the students' preferred methods. The SOAR study system, introduced by Kiewra (2005), shows promise because its components are aligned with cognitive theory and are empirically supported; however, the integrated SOAR method is untested.

The purpose of the present study, then, was to test the integrated SOAR method for fact and relationship learning by comparing integrated SOAR studiers with students who studied unaided without SOAR or studied using only portions of the SOAR method. This design would reveal whether SOAR is more effective than what students commonly do while studying and would determine whether using the full SOAR system is better than using only some of its parts. Because this is the first investigation of the SOAR system, we assessed it under optimal conditions by providing students with completed materials rather than having them create their own. Recall, for instance, that students' own study notes are less complete and less effective than ones provided by the instructor (Baker & Lombardi, 1985; Collingwood & Hughes, 1978; Kiewra, 1985b, 1985d; Morgan et al., 1988). Consequently, this is an instructional design study meant to assess optimal SOAR materials rather than a training study meant to assess how well students can acquire and apply SOAR strategies on their own.

In general, we predicted that SOAR studiers would outperform unaided studiers who tend to use the ineffective strategies mentioned previously. We also predicted that studiers using the complete SOAR method would outperform those using just some of the SOAR components, given that each component serves a unique theoretical function. In particular, we expected the SOAR method to have a greater impact on relationship learning than on fact learning because the SOAR method emphasizes meaningful, associative learning.

Method

Participants and Design

Sixty upper level undergraduate education students (30 males and 30 females with an average age of 20.5) from a large Midwestern university volunteered to participate in this study in order to fulfill a course requirement. The participants assembled in a classroom and were assigned systematically to the Control group or to one of four treatment groups: Selection (S), Selection/Organization (SO), Selection/Organization/Association (SOA), or Selection/Organization/Association/Regulation (SOAR). Systematic assignment to groups was accomplished by asking students to individually, and in consecutive order, call out a number from one to five. Each number (i.e., 1, 2, 3, 4, and 5) designated a different group. All groups included 12 participants.

Materials

Materials included a text, study materials, and tests. The 1,541-word text about wildcats was organized in a linear fashion. It described each of six wildcats in turn (tiger, lion, jaguar, leopard, cheetah, and bobcat) and described each cat along the following 13 categories in this order: genus, call, weight, coat, distinctive characteristics, habitat, range, social behavior, lifespan, prey, hunting time, hunting method, and hunting frequency. Category terms were consistent and explicit throughout the text. For example, the section on lions presented information about genus, call, and weight this way: "The lion belongs to the genus Panthera. The lion makes many different sounds, but its most common call is a mighty roar. The echo of the lion's roar has reminded many people of the sound of thunder from an approaching storm, and it can be heard from miles away. A full grown lion in the wild has a maximum weight of 400 pounds." The text contained a total of 78 important facts, with each fact corresponding to one of the six wildcats and one of the 13 categories.

Five sets of study materials were developed. The Control group studied the full wildcat text described above. The Selection (S) group studied a complete set of notes, containing all 78 facts, laid out in a linear, outline format. The notes were typed on six pages, one for each wildcat, and contained a total of 324 words. Each page listed a wildcat name flush to the left margin. The 13 categories were listed below and each was indented five spaces from the left margin. Below each category the corresponding fact was listed 10 spaces from the left margin.

The Selection/Organization (SO) group studied a complete set of notes containing all 78 facts laid out in a two-dimensional matrix format. The 195-word matrix was printed horizontally on a single page. The six wildcat names were listed across the top, the 13 categories (i.e., genus, call, weight, and so forth) were listed down the far-left column, and the wildcat facts were listed in their corresponding matrix cells. For example, at the intersection of *lion* and *weight* was the corresponding fact "400 lbs."

The Selection/Organization/Association (SOA) group also studied the wildcat matrix plus a list of 27 wildcat associations like the four following: "(1) Jungle cats (tiger, jaguar, leopard, and bobcat) are solitary and (2) have small ranges, whereas (3) plains cats (lion and cheetah) live in groups and (4) have large ranges." These associations were not stated explicitly in the text, outline, or matrix notes. However, they were easily observable in the matrix because of its two-dimensional format and its localization of associated information.

The Selection/Organization/Association/Regulation (SOAR) group studied the matrix and associations plus practice tests with provided answers to regulate learning. The practice tests were actually identical to the final tests but participants were not told this.

There were two final tests, fact and relationship. The fact test appeared in a matrix form. It listed the six wildcat names along the top and listed 9 of the 13 original categories down the left side (call, weight, habitat, range, social behavior, lifespan, prey, hunting time, and hunting frequency). The matrix's 54 cells were blank and students were asked to recall the correct fact for each cell. Internal consistency for the fact test scores was good with a Cronbach's alpha reliability coefficient of .82, exceeding the cutoff for good internal consistency of .70 (Nunnally, 1978). The relationship test contained seven open-ended questions like the following: "What is the relationship between lifespan and weight?" and "What hunting method is common among wildcats that hunt weekly?" A total of 14 relationships were reportable. Internal consistency for the relationship test scores was good with a Cronbach's alpha reliability coefficient of .80, exceeding the cutoff for good internal consistency of .70 (Nunnally, 1978).

Procedure

All participants took part in the experiment's three phases: reading, studying, and testing. Prior to the reading phase, materials were distributed and students were given general and group-specific instructions. General instructions overviewed the study's three phases and the following policies: try your best, use all your allotted time, pay attention to your own task, and work only on the task at hand. Group-specific instructions told students to study their provided materials in preparation for fact and relationship tests.

During the reading phase, all participants read along silently while the experimenter read the wildcat text aloud at a rate of 150 words per minute. This was done so that all participants had a comparable introduction to the study materials in terms of content and time. During the studying phase, immediately following the reading phase, students studied their experimenter-provided material for 20 minutes in preparation for fact and relationship tests. Immediately after, all study materials were collected and the testing phase began. During the testing phase, students were first administered the fact test and then the relationship test. All students completed the fact test within 15 minutes and the relationship test within 10 minutes.

Results

Fact tests were scored blindly by the first author who assigned one point for each of the 54 facts reported in its appropriate matrix cell. A graduate student scored 20 of the fact tests to establish interrater reliability. The interrater reliability was .99. The first author also scored relationship tests blindly and assigned one point for each of the 14 relationships reported. A graduate student scored 20 of the relationship tests to establish interrater reliability. The interrater reliability was .96. Both interrater agreement estimates exceed the threshold of adequate reliability between raters (Kimberlin & Winterstein, 2008; Nunnally, 1978).

Separate univariate analysis of variance (ANOVA) tests were conducted on fact test scores and on relationship test scores. A multivariate analysis of variance (MANOVA) could have been used for the statistical analysis, but the ANOVA was more appropriate for these data for three reasons. First, the univariate approach is more powerful statistically than the multivariate approach, especially when the variances are homogeneous (Girden, 1992). Second, the MANOVA is the statistic of choice when the dependent variables are presumed to be related (Harwell, 1988). The fact and relationship tests in this study assessed two distinct types of knowledge. It is possible for students to learn isolated facts but not grasp the overriding relationships and vice versa. Third, the MANOVA procedure is more appropriate with large sample sizes (Smith, 1996). This study included 60 participants thereby making the ANOVA the more appropriate test.

The ANOVA for fact scores revealed overall group differences, $F\,(4, 55) = 3.37, p = .015$. The estimated effect size (partial eta-squared) was .19. This moderately large effect size for the fact test means that much of the variance in fact test scores

Table 2

Group Means, Percentage Correct, and Standard Deviations on Fact and Relationship

Groups	Tests Fact	 Relationship
Control	41.29, 76 (4.46)	5.54, 40 (2.67)
S	45.58, 84 (6.23)	7.54, 54 (2.24)
SO	49.08, 91 (5.72)	9.45, 68 (2.10)
SOA	43.58, 81 (6.84)	8.42, 60 (3.33)
SOAR	43.17, 80 (4.22)	11.29, 81 (2.67)

***Note*. Maximum score is 54 for fact test and 12 for relationship test.**

is explained by the different study methods used by the groups (i.e., the independent variable). Fisher's least significant difference (LSD) follow-up tests revealed these specific group differences: The SO group recalled more facts than the Control, SOA, or SOAR groups. In other words, studying a matrix organizer produced greater factual recall than studying the complete text or studying the matrix plus associations or the matrix plus associations and practice tests. The group means and Fisher's LSD test for the fact test are displayed in Tables 2 and 3, respectively.

The ANOVA for relationship scores revealed overall group differences as well, $F(4, 55) = 7.91, p = .004$. The estimated effect size (partial eta-squared) was .37. This large effect size (Cohen, 1988; Pallant, 2007) means that much of the variance in relationship test scores is explained by the different study methods used by the groups (i.e., the independent variable). Fisher's LSD follow-up tests revealed these specific group differences: The SOAR group reported more relationships than all groups except the SO group; the SO group reported more relationships than the Control and Selection groups; and the SOA group reported more relationships than the Control group. The group means and Fisher's LSD test for the relationship test are displayed in Tables 2 and 4, respectively.

Table 3

Fisher's Least Significant Results for Fact Test

Group A	Group B	Mean Difference	*p*-value
Control	S	-4.29	.06
	SO	-7.80*	.01
	SOA	-2.29	.32
	SOAR	-1.88	.42
S	SO	-3.50	.06
	SOA	2.00	.38
	SOAR	2.41	.29
SO	SOA	5.50*	.01
	SOAR	5.92*	.01
SOA	SOAR	0.42	.86

* $p < .05$.

Table 4

Fisher's Least Significant Results for Relationship Test

Group A	Group B	Mean Difference	*p*-value
Control	S	-2.00	.07
	SO	-3.92*	.01
	SOA	-2.88*	.01
	SOAR	-5.75*	.00
S	SO	-1.92	.08
	SOA	-0.88	.42
	SOAR	-3.75*	.01
SO	SOA	1.04	.34
	SOAR	-1.83	.09
SOA	SOAR	-2.88*	.01

*$p < .05$.

Discussion

We predicted that the integrated SOAR study method would prove more effective than studying unaided without SOAR and studying using only some of the SOAR techniques. We also predicted that findings would be more pronounced for the relationship learning than fact learning. With respect to the first prediction, SOAR studiers outperformed the Control group by a wide margin on the relationship test (81% versus 40%) but not on the fact test (80% versus 76%). With respect to our second prediction, the integrated SOAR method was superior to most of its parts for relationship learning (Selection and Selection/Organization/Association) but not for fact learning. Thus, the third prediction held true: The SOAR method had a greater impact on relationship learning than on fact learning.

Our primary predictions, that using the full SOAR method would result in greater learning than studying unaided or when using some of the SOAR components, did not hold for the fact test where studying the matrix organizer (SO) produced the greatest learning—greater than the Control group and greater than those who studied the matrix plus associations (SOA) or plus associations and practice tests (SOAR). Our primary explanation pertains to divided attention (Sergeant, 1996). The association material compelled students to focus on relationships and drew attention away from learning facts. So did the regulation material that pertained to relationship learning. There was regulation material germane to fact learning, but it was essentially a repeat of the matrix study material both in form and content. The regulation matrix contained just 30% fewer facts than the study matrix. A related and secondary explanation pertains to cognitive load (Sweller, 1994) and study time. Studiers with matrix notes and associations or with matrix notes, associations, and practice tests might have had too much information to process in just 20 minutes. In essence, associations and practice tests were perhaps too much of a good thing for learning facts under limited time constraints.

Two present findings supported previous findings. First, students in our Control group studied without study aids and earned the lowest relative scores on fact and relationship tests. Their fact score was reliably different from the SO group; their relationship score was reliably different from three of the four SOAR groups. This is further evidence that college students do not study effectively on their own and need study aids or study strategy instruction (Gubbels, 1999; Kiewra, 1985b; Pressley et al., 1997). Second, students studying matrix notes (M = 68%) learned more relationships than students studying linear notes (M = 54%) even though both sets of notes were content equivalent. Matrices localize related information and showcase relationships, sometimes making them apparent with a glance; outlines separate related ideas and obscure relationships (Kiewra, 1994; Kiewra et al., 1999). Accordingly, instructors should provide students with matrix notes when presenting comparative information or teach students this effective study strategy.

Four methodological limitations narrow the generality of results. First, this was an instructional design study that assessed the learning potential of instructor-provided materials rather than a training study that assessed the learning potential of student-generated materials. An instructional design study was conducted to assess preliminarily the full potential of the SOAR study method. Findings, then, reflect outcomes that are likely when students are given optimal SOAR materials. Future research should determine the trainability of the SOAR method and its effectiveness when students create their own SOAR materials.

The second limitation was that SOAR group participants studied practice tests during the regulation phase that were identical to posttests. Here again, this was done to provide students with optimal materials so that the full effects of the SOAR system could be assessed. This limitation too can be overcome by future research that determines the trainability of the regulation process and the effectiveness of students generating their own practice test items. It is conceivable that students might benefit optimally from their own practice questions because generating and answering them is even more regulatory than answering provided questions. As an aside, future researchers should take note that fact test regulation was not effective, whereas relationship test regulation was effective. This pattern of results, we believe, was due to two test factors: amount and familiarity. First, there were many more fact questions than relationship questions, making it easier to benefit from relationship items than fact items. Second, students are generally more familiar with fact questions than relationship questions and tend to study facts when studying on their own (Bausch & Becker, 2001; Gubbels, 1999; Jairam, 2009). Providing the relationship practice questions, therefore, provided a greater boost than providing fact practice questions.

A third limitation was that long-term retention was not assessed. Participants completed tests immediately after studying. Future research could examine what students retain following a delay. Based on results reported by Kauffman and Kiewra (in press), however, we would expect delayed findings to mirror immediate findings. Kauffman and Kiewra compared outline and matrix studiers on immediate, delayed, and relearning tasks and found consistent findings favoring matrix studiers across tasks.

The last limitation is that our results apply only to comparative materials, such as when various wildcats are compared along several categories such as weight and habitat. Although the comparative structure used here is just one of several knowledge structures named by Jonassen and colleagues (Jonassen, Beissner, & Yacci, 1993), it is perhaps the most common. Anytime a topic is studied, such as the Renaissance period or multiple intelligence theory, such topics are ordinarily studied relative to associated topics such as the Baroque period and general intelligence theory, respectively. Still, the SOAR system should be investigated for other knowledge structures too.

In summary, this preliminary study confirmed that the integrated SOAR system is helpful for learning relationships; however, parts of the system might hinder fact learning when study time is constrained. A natural follow-up to the present study is one where study time is unconstrained or more liberal in order to better gauge the SOAR system's full potential. This study also examined SOAR techniques when optimal study materials were supplied. Although it is important to first judge treatments under the best light possible (Mayer, 2008), future research should examine SOAR in more natural settings and ultimately determine the effects of student-generated SOAR materials among students trained to SOAR to success.

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