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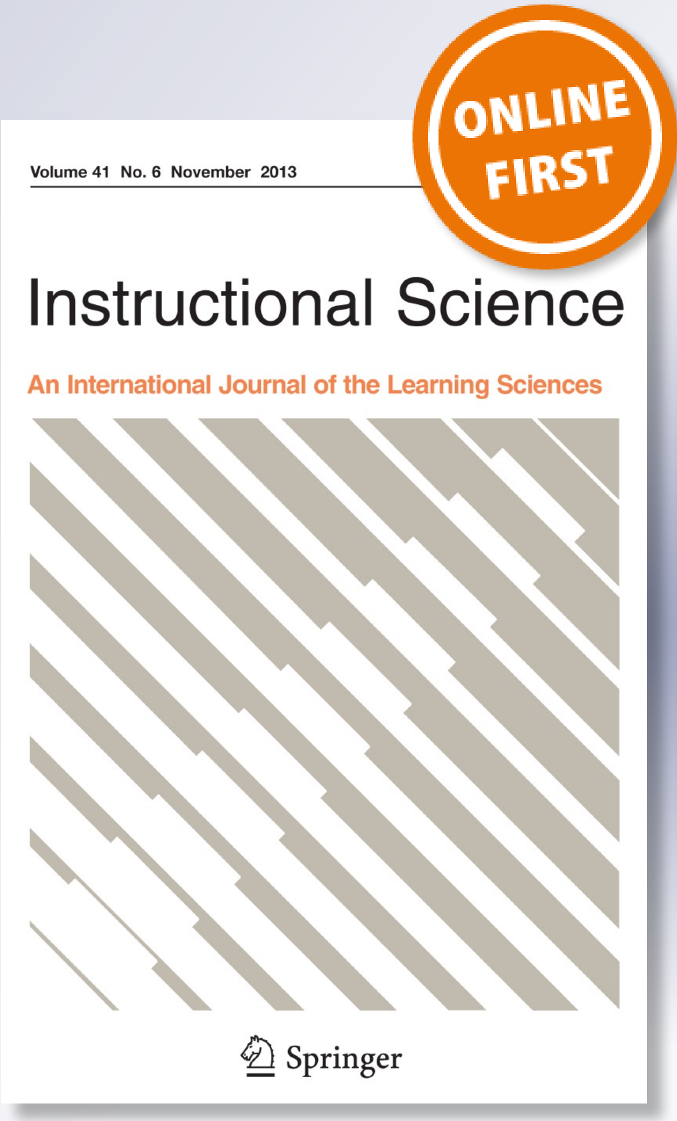

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SOAR versus SQ3R: a test of two study systems

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Abstract Although researchers have long investigated ways to improve study habits and raise achievement, few studies compare study strategy systems with one another. No study to date has compared the long popular SQ3R (Survey, Question, Read, Recite, Review) system with the more modern SOAR (Select, Organize, Associate, Regulate) system. This study directly compared SQ3R and SOAR to determine which is most effective. College students trained in the SQ3R or SOAR system and given corresponding study materials used their respective method to study a text in preparation for a test assessing fact, relationship, and concept learning. Results confirmed that students who used the SOAR system outperformed those who used the SQ3R system and learned 20 % more relationships, 14 % more facts, and 13 % more concepts. Results were attributed to SOAR's cognitive processing advantages over SQ3R.

Keywords SQ3R · SOAR · Learning strategies

Introduction

Suppose students were to learn the information about reinforcement schedules found in Table 1. How could learning be maximized? According to Mayer (2002, 1996), maximal learning depends on the operation of three cognitive processes: selection, organization, and integration. As shown in Fig. 1, these three processes align with the information processing system. Selection aids attention, organization aids working memory processes, and integration aids encoding and retrieval. Mayer calls this the SOI model of learning and

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Table 1 Brief reinforcement schedules text

There are four types of reinforcement schedules. A **fixed ratio** schedule is one where reinforcement occurs following a *constant number* of responses. For example, every time a student completes 4 math problems a reward is given. This schedule produces *rapid responding*. A **variable ratio** schedule is one where reinforcement occurs following a *changing number* of responses. For example, a student might need to complete 4 then 6 then 2 problems to earn a reward each time. This schedule produces *rapid responding*. A **fixed interval** schedule is one where reinforcement is delivered for the first response made following a *constant time interval*. For example, a student might receive a reward for the first math problem completed after a 4 min time interval has elapsed. This schedule produces *slow responding*. A **variable interval** schedule is one where reinforcement is delivered for the first response made following a *changing time interval*. For example, a student might receive a reward for the first response made after 4 min then 6 min and then 2 min. This schedule produces *slow responding*

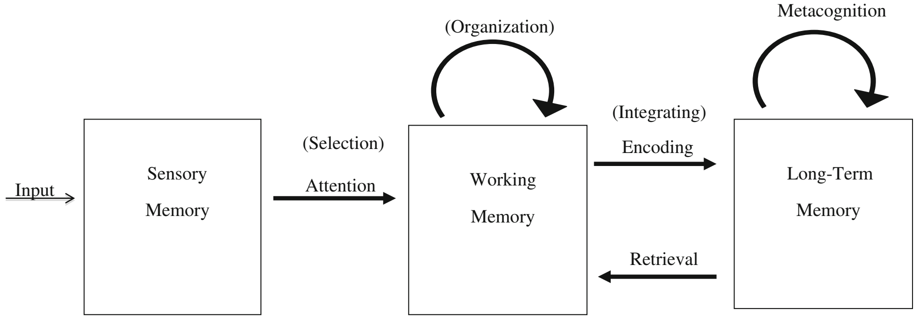

Fig. 1 Information processing model (combined with Mayer's SOI model)

instruction because these processes can be engaged through learner strategies or through instructional methods.

Returning to the reinforcement schedules material, selection might be aided by signaling the critical information for further study as shown by the bolded and italicized material in Table 1. Organization might be aided using a graphic organizer such as that shown in Fig. 2. The graphic organizer makes it easy to compare the four schedules in terms of reinforcement delivery, example, and response rate. Integration is aided by building internal and external connections. Internal connections are integrations within the material. For example, "ratio schedules are based on number of responses, whereas interval schedules are based on time." External connections are integrations outside the material such that presented information is connected with prior knowledge. For example, "slot machines operate on a variable ratio schedule." Most learning theorists (Biggs, 1988; Schraw et al. 2006) would add a fourth component to Mayer's SOI model: metacognition, and Mayer (2011) actually does just that. Metacognition involves assessing one's understanding. Metacognition might be aided through practice testing prior to the actual test. For example, answering questions such as "How is reinforcement delivered in a fixed ratio schedule?" and "Which two techniques involve changing the reinforcement pattern?" informs students about their readiness for the actual test. Figure 1 includes metacognition as a process for assessing recall from long-term memory.

	Ratio		Interval	
Fixed	Interval	Fixed	Interval	Fixed
Reinforcement Delivery:	After fixed number of responses	After changing number of responses	After fixed amount of time	After changing amount of time
Example:	4 responses – reward 4 responses – reward 4 responses – reward	4 responses – reward 6 responses – reward 2 responses – reward	4 minutes – response – reward 4 minutes – response – reward 4 minutes – response – reward	4 minutes – response – reward 6 minutes – response – reward 2 minutes – response – reward
Response Rate:	Rapid	Rapid	Slow	Slow

Fig. 2 Matrix organizer for reinforcement schedules

The SOAR study method

Although Mayer (1996) and others (Harp and Mayer 1997; Sternberg 1985; Sung et al. 2008) provided empirical support for SOI components, no one has tested those components in combination to determine the value of SOI as a study system. Recently, however, Kiewra (2005, 2009) developed a study system called SOAR based on Mayer's (1996) SOI model plus metacognition. SOAR is an acronym for the system's four components: select, organize, associate, and regulate. As seen in Table 3, SOAR components align with Mayer's SOI model plus metacognition. Both models use the terms select and organize. SOI's integration component is comparable with SOAR's associate component. And, SOAR's regulate component is comparable with metacognition.

SOAR was not only designed in line with Mayer's (1996) theoretical model but also in line with empirical research that can remedy students' well-documented struggles to select important information, organize and associate it, and regulate understanding. In terms of selection, note taking is a primary method for selecting lecture and text information (Crooks et al. 2007), yet students actually select just one-third of important ideas leaving them with insufficient material for further review (Kiewra 1985a, b; Titsworth 2004). Meanwhile, research confirms that note completeness is positively related to achievement (Baker and Lombardi 1985; Kiewra 1983, 1987). Given this, the goal for selection is the construction of complete notes.

In terms of organization, most students do little if any reorganization of lecture or text material (Rachal et al. 2007). When they do, they tend to organize information linearly in lists or outlines that actually obscure the relationships across topics, such as those among reinforcement schedules (Gubbels 1999; Robinson and Kiewra 1995). Meanwhile, research confirms that achievement is maximized when information is displayed graphically in matrices, such as that in Fig. 2, rather than linearly (Day 1988; Kauffman and Kiewra 1999; Robinson and Kiewra 1995). Given this, the goal for organization is the construction of graphic organizers.

In terms of association, most students fail to connect ideas and instead study them one at a time in a piecemeal fashion (Bausch and Becker 2001). For example, they might study the response rates of reinforcement schedules, shown in Fig. 2, one at a time rather than connect them so that the following relationship is evident: Ratio schedules lead to rapid responding, whereas interval schedules lead to slow responding. Meanwhile, research confirms that association produces higher achievement than piecemeal learning (Bransford et al. 2000). Given this, the goal of association is the construction of internal and external associations.

In terms of regulation, most students fail to monitor and assess learning (Bausch and Becker 2001). Instead, students commonly employ rote strategies such as rereading,

Table 2 Comparison of SOAR and SQ3R components with respect to cognitive processes

	Cognitive processes			
	Selection	Organization	Integration	Metacognition
SOAR Components:	Select	Organize	Associate	Regulate
SQ3R Components:	Survey	–	–	Recite
	Question			Review
	Read			

rewriting, and rehearsal that have proven ineffective (Nist and Holschuh 2000). Meanwhile, research confirms that practice testing aids achievement (Karpicke and Blunt 2011; King 1992). Given this, the goal of regulation is the construction and completion of a practice test.

Research on the SOAR method is limited but promising. In two studies, one involving text learning (Jairam and Kiewra 2009) and the other involving computer learning (Jairam and Kiewra 2010), students who used the SOAR study system achieved more than students who used their preferred strategies. Students preferred strategies, by the way, were at odds with SOAR strategies (Jairam and Kiewra 2010). Most students recorded incomplete notes in a linear, non-graphic, form; focused on single facts instead of associations among ideas; and used repetitive review strategies rather than self-testing.

Although SOAR is theoretically grounded and empirically supported, both component-by-component and as a system relative to students' preferred strategies, how it stacks up against other study systems is unknown. Establishing its place relative to other systems is important because research methodologists (Creswell 2003; Glenny et al. 2005) contend that head to head comparisons are the ultimate test for competing methods. When it comes to other study systems, one in particular stands large: SQ3R, the most popular and long-standing study method.

The SQ3R study method

For over 70 years now, educators have advocated that students use an ever-popular study system called SQ3R (Robinson 1941). SQ3R is an acronym for the system's five steps: Survey, Question, Read, Recite, and Review. According to Robinson and others (Adams et al. 1982; McCormick and Cooper 1991; Tadlock 1978), students first survey text headings to get an idea what the text is about. Next, they create questions based on those headings that serve to peek curiosity and activate prior knowledge (Robinson 1962). Then, students read the text seeking to answer the questions created. Next, during the recite stage, students answer their self-generated questions in their own words. Last, students review all the information by practicing its recall from memory.

Although SQ3R has endured, its empirical track record is suspect. First, empirical research is limited and much of that research has serious methodological flaws (see McCormick and Cooper 1991). Second, there is minimal research supporting SQ3R. Students who use SQ3R often achieve no higher than students who use their preferred methods (Butler 1983; Flippo and Caverly 2000; Manzo and Manzo 1995; McCormick and Cooper 1991; Scappaticci 1977). Third, research confirms that SQ3R is difficult for students to learn and apply (Caverly 1985; Flippo and Caverly 2000; Spor and Schneider 1999). Despite these deficiencies and criticisms, SQ3R still flourishes today. Our own casual Google search uncovered many college professors or learning assistance centers recommending SQ3R to students.

SQ3R's limitations perhaps reside in its early design that predated cognitive psychology. According to Mayer (2002), pre-cognitive learning theorists favored an information acquisition view where learning involved a passive addition of information usually through rote learning activities like rehearsal. Cognitive psychologists later replaced that view with the knowledge construction view where learning involved building meaningful knowledge structures through processes like organization and integration. In fact, when SQ3R is examined from a modern day perspective, it seemingly lacks knowledge construction mechanisms. Returning to Table 3, the bottom row shows how SQ3R fits with Mayer's (2002, 1996) cognitive theory. SQ3R's first three steps (survey, question, and read) fit best with the cognitive process of selection. According to Mayer (1996), all three steps are aimed at selecting critical information for further study. Meanwhile, SQ3R's last two steps (recite and review) fit best with the cognitive process of metacognition. According to Tadlock (1978), both steps are aimed at assessing understanding. Conspicuously absent from SQ3R, then, are steps meant to aid the cognitive processes of organization or integration.

Purpose and predictions

The purpose of the present study was to compare SQ3R and SOAR to determine if one is more effective than the other. Although both systems have been compared to students' preferred methods, how they compare with one another is unknown. In this study, college students were trained in the SQ3R or SOAR system and then asked to study a long text passage in preparation for fact, relationship, and concept achievement tests. While studying the text, students also studied expertly designed and provided SQ3R or SOAR study materials, respectively. Thus, the two study systems were compared in this initial investigation under the best conditions possible: trained students studying ideal materials. Our reasoning for providing expertly designed materials mirrored that of McCormick and Cooper (1991) who also investigated SQ3R using teacher-directed lessons. They reasoned that if SQ3R did not work under ideal teacher-assisted conditions initially, then it was unlikely to work under student-independent conditions subsequently, especially given SQ3R's poor track record for independent student use.

It was predicted that SOAR studiers would outperform SQ3R studiers on fact, relationship, and concept tests because of SOAR's theoretical advantages in terms of information organization and integration (see Table 3). These processes are linked to high achievement on retention tests, like the fact test, and on transfer tests, like the relationship and concept tests (Mayer 1996). In particular, graphic organizers (used in SOAR's organize component) and their integrative study (used in SOAR's associate component) help learners form relationships, acquire facts inherent in those relationships, and link new information to prior knowledge such that they can recognize new concept examples (Atkinson et al. 1999; Kauffman and Kiewra 2010; Mayer 1979; Robinson and Kiewra 1995; Stull and Mayer 2007).

Methods

Participants and design

Twenty-five undergraduate students enrolled in educational psychology classes at a large Mid-western university were assigned randomly to either the SQ3R or SOAR group and received course credit for participation. All participants were juniors or seniors and all had GPAs of 2.5 or higher. Eighty percent were female.

Materials

Materials included a demographic survey and those for training, studying, and testing.

Demographic survey

The three-item multiple-choice survey asked participants to declare their gender, class standing, and overall GPA.

Training

SQ3R and SOAR training materials shared several commonalities. Both were presented via PowerPoint, included 40 slides, were experimenter-paced taking 30 min to complete, and followed the same training regime: introduction, example, guided practice, and unguided practice. During the introduction phase, the system's steps were listed and described in turn. During the example phase, the system was demonstrated for a passage about symbiosis. During the guided study phase, participants practiced the steps one at a time for a passage about animal behavior. Prompts preceded each step and detailed feedback followed participants' written attempts to use each step. During the unguided phase, participants tried to use the entire system without prompting for a passage about wildcats. Detailed feedback for all steps was provided after 15 min.

Training materials differed only with regard to training content and that content followed the methods set out by the systems' creators: Robinson (1941) for SQ3R and Kiewra (2005) for SOAR. SQ3R materials trained participants to Survey (skim headings and write a statement indicating what the text is about), Question (turn headings into written questions), Read (read the text seeking to answer questions), Recite (write answers to questions in your own words), and Review (practice recalling information from memory). SOAR materials trained participants to Select (record notes that contain main ideas, details, and examples), Organize (create graphic organizers that aid comparison), Associate (associate text ideas with each other and with things you already know), and Regulate (create and answer fact and relationship questions).

Studying

Study materials included a text about reinforcement schedules (a longer and more detailed version than the brief text in Table 1) and either SQ3R or SOAR supplements. The 2100-word text was typed and printed on four standard pages. It covered each of the four reinforcement schedules in turn (fixed-ratio, variable-ratio, fixed-interval, and variable-interval) by providing a section for each that included information pertaining to reinforcement delivery, example, and response rate and pattern. In no case were the four schedules compared or contrasted. The text concluded with a separate section on extinction that addressed extinction difficulty for each schedule in turn.

The SQ3R and SOAR supplements were created by the experimenters and were intended to be ideal study materials based on the methods set out by the systems' creators (Kiewra 2005, for SOAR; Robinson 1941, for SQ3R). The SQ3R supplement guided students through each SQ3R component. For the Survey component, the following overview statement, based on text headings, was provided: "This text is about four types of reinforcement schedules: fixed ratio, variable ratio, fixed interval, and variable interval. It also discusses the process of extinction." For the Question component, eight questions stemming from text headings were provided. Question examples included: (a) What are the four types of schedules?, (b) What are interval schedules?, (c) What is a fixed interval schedule?, and (d) What is extinction? For the Read component, students were encouraged to read the text seeking answers to questions. For the Recite component, complete but paraphrased written answers to the eight questions were given. For example, this was the answer provided for the "What are interval schedules?" question: "In interval schedules, responses are reinforced only after a certain amount of time has passed. There are two types: fixed and interval." For the Review component, the eight questions were re-presented along with answers and students were asked to try to recall question answers from memory before checking written answers.

The SOAR supplement contained a four-page set of linear notes with headings and bullet points that briefly recounted the text's main ideas, details, and examples (Select); a matrix graphic organizer comparing the four schedules in terms of reinforcement delivery, example, behavior rate, behavior pattern, and extinction (similar to the abbreviated matrix in Fig. 2 (Organize); a list of seven associations within the material (e.g., "Ratio schedules produce rapid responding; interval schedules produce slow responding") and five associations outside the material (e.g., "A rat that must always press a bar 15 times to receive food is reinforced on a fixed ratio schedule" (Associate); and 20 recall questions—10 fact (e.g., "What is the rate of behavior for a variable interval schedule?") and 10 relationship (e.g., "What two schedules produce steady responding?")—with answers provided on the next page (Regulate).

Testing

There were two tests: vocabulary and achievement. The 10-item multiple-choice vocabulary test taken from the verbal portion of a sample Scholastic Aptitude Test was used as both a filler task and as a means for determining group ability levels. The achievement test included 30 multiple-choice items, each with four choices. Ten items measured fact learning (e.g., Which schedule is associated with low responding and pauses?), 10 items measured relationship learning (e.g., Which schedules involve slow responding?), and 10 items measured concept learning (e.g., Every time a factory worker makes 5 widgets, she is paid $30. What schedule is this?). Fact and relationship test items differed from SOAR regulation items in both form (recognition versus recall, respectively) and wording. Moreover, concept items were not included in the SOAR study material.

Procedure

All participants gathered in a computer lab and were seated randomly at computers loaded with SQ3R or SOAR materials. Following general instructions, participants completed the demographic survey and then proceeded through the training, studying, and testing phases of the experiment. During the 30 min training phase, participants viewed their respective training materials (SQ3R or SOAR) via computer and completed practice exercises on notebook paper. During the 45 min study phase that followed, participants were given the schedules of reinforcement text and their respective supplement (SQ3R or SOAR). They were advised to read the text one time and then study the supplement as they prepared for a test measuring facts, relationships, and new example recognition (concept). They were permitted to record additional notes in the text or supplement if desired. During the testing phase, participants first took the vocabulary test to clear the reinforcement schedules information from working memory. Next, participants were allowed 20 min to complete the achievement test. Finally, all participants were debriefed and then dismissed simultaneously.

Results

Scoring and Analyses

Each dependent measure—vocabulary, fact, relationship, and concept—contained 10 objective items and were therefore scored from 0 to 10 using pre-established scoring keys. The Shapiro–Wilk test of normality was conducted on all dependent measures because of the small sample size. The *p*-values for the four tests ranged from 0.100 to 0.234, indicating that the data came from a normal distribution. Separate one-tailed *t* tests were used to test for achievement differences between the SOAR and SQ3R groups on the three achievement measures (i.e., fact, relationship, and concept tests) because our predictions favored SOAR over SQ3R. Although the achievement measures were moderately correlated (*r* ranged from 0.509 to 0.567), a Multivariate Analysis of Variance (MANOVA) was not appropriate for this study. *T* tests were used for three reasons. First, the *t* test is the statistic of choice for two independent samples with small sample sizes (Larson and Farber 2012). Second, MANOVA is used for dependent measures that are related (Harwell 1988). The fact, relationship, and concept tests measured three distinct types of knowledge: factual, relational, and conceptual, respectively (Gall 1970). Third, MANOVA increases the complexity and ambiguity of results and, therefore, should be avoided if possible (Tabachnick and Fidell 1983).

Group differences

The SOAR and SQ3R groups did not differ on the 10-item vocabulary test, $t\,(23) = 1.21$, $p = .24$, indicating that the SOAR ($M = 5.77$, $\mathrm{SD} = 2.24$) and SQ3R ($M = 4.75$, $\mathrm{SD} = 1.96$) groups were comparable with respect to verbal ability. Therefore, we proceeded with simple *t* tests without covariate adjustments.

There was a significant group effect for facts, $t\,(23) = 2.25$, $p < 0.02$. The SOAR group ($M = 7.00$, $\mathrm{SD} = 1.29$) correctly recognized 14 % more facts than the SQ3R group ($M = 5.58$, $\mathrm{SD} = 1.83$). This effect was large; Cohen's *d* was 0.90.

There was also a significant group effect for relationships, $t\,(23) = 2.26$, $p < 0.02$. The SOAR group ($M = 7.15$, $\mathrm{SD} = 2.58$) correctly recognized 20 % more relationships than the SQ3R group ($M = 5.08$, $\mathrm{SD} = 1.92$). This effect was also large; Cohen's *d* was 0.91.

Last, there was a significant group effect for concepts, $t\,(23) = 1.84$, $p < 0.035$. The SOAR group ($M = 7.15$, $\mathrm{SD} = 2.38$) correctly recognized 13 % more concepts than the SQ3R group ($M = 5.67$, $\mathrm{SD} = 1.61$). This effect was medium to large; Cohen's *d* was 0.72.

Discussion

The prediction that SOAR studiers would outperform SQ3R studiers was confirmed. The SOAR group learned about 14 % more facts, 20 % more relationships, and 13 % more concepts than the SQ3R group. The concept learning difference is especially noteworthy because SOAR studiers had no training or practice in concept testing and because concept testing represents a form of transfer learning (Mayer 2008).

SOAR's theoretical advantage over SQ3R is that each SOAR component engages a cognitive process critical for effective learning. In this study, the selection process was engaged by giving SOAR participants notes containing selected ideas. Focusing on selected information can guide attention (Sternberg 1985) and reduce extraneous cognitive load (Crooks et al. 2007). The organization process was aided for SOAR participants who studied information displayed in a matrix organizer. Matrices organize information in an economical manner that reduces cognitive load (Crooks et al. 2007) and highlights relationships (Kauffman and Kiewra 2010). Providing SOAR studiers with associations facilitated the integration process. Associative learning allows meaningful and memorable relationships to be drawn within presented material and between presented material and prior knowledge (Mayer 2008). Last, SOAR's regulation component, via practice testing, engaged the metacognition process (Karpicke et al. 2009).

In contrast, SQ3R is comprised of strategies that largely ignore the organization and integration processes critical to learning (Mayer 1996). Some have argued that SQ3R engages rote learning processes associated with merely searching and memorizing information (Cook and Mayer 1983). Others have argued that even SQ3R's survey and question components rest on faulty assumptions, namely that: (a) text headings capture important information; (b) created questions test information captured by text headings; and (c) created questions test main ideas (Anderson and Armbruster 1985).

In conclusion, this study follows a long history of others that cast doubt on the effectiveness of SQ3R (e.g., Butler 1983; McCormick and Cooper 1991; Scappaticci 1977). That doubt was especially pervasive in this study given that students were trained in SQ3R methods and were provided with optimal SQ3R study materials. At the same time, this study adds to an emerging literature base showing the effectiveness of SOAR. The SOAR study system has now proven its value over students' preferred methods in text and computer-based settings (Jairam and Kiewra 2010, 2009) and over SQ3R. Moreover, the head-to-head comparison of SQ3R and SOAR is also important methodologically. Few studies have made such comparisons between study systems. And, it is only through such experimental designs that best practices can be determined and made available to the many students using ineffective study practices.

Limitations and recommendations for future research

Two limitations with implications for future research were identified. First, participants studied experimenter-provided materials rather than student-generated materials. This was done to ensure that students used ideal materials and followed studying procedures properly, especially given evidence that SQ3R can be difficult to learn and employ even after 10 or more hours of training (Caverly 1985). Ideally, future studies should compare SOAR to SQ3R using student-generated materials. SOAR's cognitive advantages over SQ3R might then be more pronounced than in the present study because self-generated study materials are sometimes more effective than instructor-provided materials (Robinson et al. 2006; Rosenshine et al. 1996).

The second limitation pertained to our operationalization of the SQ3R question step. We followed Robinson's (1962) instructions by creating questions based on text headings. Robinson instructs readers to turn headings into questions to stimulate curiosity and prior knowledge and to orient one's self to what will be read. Robinson does not specify the type or level of question (e.g., factual or relational) that should be generated but suggests that making questions from headings should be done instantly. Robinson states, "Asking a question should be done in a moment; do not spend time and effort in trying to word it well" (p. 39). The exclusively fact questions used for SQ3R in the present study were consistent with Robinson's procedures and intentions. Still, future research might extend SQ3R boundaries and investigate the effect of different question types.

References

Adams, A., Carnine, D., & Gersten, R. (1982). Instructional strategies for studying content area texts in the intermediate grades. *Reading Research Quarterly, 18*, 27–55.

Anderson, T. H., & Armbruster, B. B. (1985). Studying strategies and their implication for textbook design. In T. M. Duffy & R. Waller (Eds.), *Designing useable texts* (pp. 159–177). Orlando: Academic Press.

Atkinson, R. K., Levin, J. R., Kiewra, K. A., Meyers, T., Kim, S. I., Atkinson, L. A., et al. (1999). Matrix and mnemonic text-processing adjuncts: Comparing and combining their components. *Journal of Educational Psychology, 91*, 342–357.

Baker, L., & Lombardi, B. R. (1985). Students' lecture notes and their relation to test performance. *Teaching of Psychology, 12*, 28–32.

Bausch, A., & Becker, K. (2001). *A study of students' lack of study and organizational strategies with middle school and high school students*. Master's thesis, Saint Xavier University and Skylight Professional Development Field-Based Masters Program. (ERIC Document Reproduction Service No. ED455461). Retrieved from the ERIC database.

Biggs, J. B. (1988). The role of metacognition in enhancing learning. *Australian Journal of Education, 32*, 127–138.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school (expanded edition)*. Washington: National Academy Press.

Butler, T.H. (1983). Effect of subject and training variables on the SQ3R study method. Unpublished doctoral dissertation, Arizona State University, Tempe.

Caverly, D. C. (1985, December). Textbook study strategies: A meta-analysis. Paper presented at the National Reading Conference, San Diego, CA.

Cook, L., & Mayer, R. (1983). Reading strategies training for meaningful learning from prose. In M. Pressely & J. R. Levin (Eds.), *Cognitive strategy research: Educational applications* (pp. 87–131). New York: Springer-Verlag.

Creswell, J. W. (2003). *Mixed methods approaches. Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks: Sage Publications.

Crooks, S., White, D., & Barnard, L. (2007). Factors influencing the effectiveness of note taking on computer-based graphic organizers. *Journal of Educational Computing Research, 37*, 369–391.

Day, R. S. (1988). Alternative representations. In G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 22, pp. 261–303). New York: Academic Press.

Flippo, R. F., & Caverly, D. C. (2000). *Handbook of college reading and study strategy research*. Hillsdale: Lawrence Erlbaum.

Gall, M. D. (1970). The use of questions in teaching. *Review of Educational Research, 40*, 707–721.

Glenny, A. M., Altman, D. G., Song, F., Sakarovitch, C., Deeks, J. J., D'Amico, R., et al. (2005). Indirect comparisons of competing interventions. *Health Technology Assessment, 9*, 1–4.

Gubbels, P.S. (1999). College student studying: A collected case study. Unpublished doctoral dissertation, University of Nebraska-Lincoln.

Harp, S., & Mayer, R. E. (1997). Role of interest in learning from scientific text and illustrations: On the distinction between emotional interest and cognitive interest. *Journal of Educational Psychology, 89*, 92–102.

Harwell, M. R. (1988). Univariate vs. multivariate tests: ANOVA versus MANOVA. *Educational Research Quarterly, 12*, 20–28.

Jairam, D., & Kiewra, K. A. (2009). An investigation of the SOAR study method. *Journal of Advanced Academics, 20*, 602–629.

Jairam, D., & Kiewra, K. A. (2010). Helping students soar to success on computers: An investigation of the SOAR study method for computer-based learning. *Journal of Educational Psychology, 102*, 601–614.

Karpicke, J. D., & Blunt, J. R. (2011). Retrieval practice produces more learning than elaborate studying with concept mapping. *Science, 331*(6018), 772–775.

Karpicke, J. D., Butler, A. C., & Roediger, H. L. (2009). Metacognitive strategies in student learning: Do students practice retrieval when they study on their own? *Memory, 17*, 471–479.

Kauffman, D. F., & Kiewra, K. (1999, April). *Indexing, extraction, and localization effects from learning from matrices, outlines, and text*. Paper presented at the annual meeting of the American Educational Research Association, Montreal.

Kauffman, D. F., & Kiewra, K. (2010). What makes the matrix so effective: An empirical test of indexing, extraction, and localization effects. *Instructional Science, 38*, 679–705.

Kiewra, K. A. (1983). The process of review: A levels of processing approach. *Contemporary Educational Psychology, 8*, 366–374.

Kiewra, K. A. (1985a). Learning from a lecture: An investigation of note taking, review, and attendance at a lecture. *Human Learning, 4*, 73–77.

Kiewra, K. A. (1985b). Students' note-taking behaviors and the efficacy of providing the instructor's notes for review. *Contemporary Educational Psychology, 10*, 378–386.

Kiewra, K. A. (1987). Notetaking and review: The research and its implications. *Instructional Science, 16*, 233–249.

Kiewra, K. (2005). *Learn how to study and SOAR to success*. Upper Saddle River: Pearson, Prentice Hall.

Kiewra, K. A. (2009). *Helping students SOAR to success*. Thousand Oaks: Corwin.

King, A. (1992). Comparison of self-questioning, summarizing, and note taking-review as strategies for learning from lectures. *American Educational Research Journal, 29*, 303–323.

Larson, R., & Farber, B. (2012). *Elementary statistics: Picturing the world*. New York: Prentice Hall.

Manzo, A. V., & Manzo, U. C. (1995). *Teaching children to be literate: A reflective approach*. Fort Worth: Harcourt Brace College.

Mayer, R. E. (1979). Can advance organizers influence meaningful learning. *Review of Educational Research, 49*, 371–383.

Mayer, R. E. (1996). Learning strategies for making sense out of expository text: The SOI model for guiding three cognitive processes in knowledge construction. *Educational Psychology Review, 8*, 357–371.

Mayer, R. E. (2002). *The Promise of educational psychology Volume 2: Teaching for meaningful learning* (2nd ed.). Upper Saddle River: Merrill Education.

Mayer, R. E. (2008). Applying the science of learning: Evidence-based principles for the designing of multimedia instruction. *American Psychologist, 63*, 760–769.

Mayer, R. E. (2011). *Applying the science of learning*. Upper Saddle River: Merrill Education.

McCormick, S., & Cooper, J. Q. (1991). Can SQ3R facilitate secondary learning disabled students' literal comprehension of expository text? Three experiments. *Reading Psychology, 12*, 239–271.

Nist, S. L., & Holschuh, J. L. (2000). Comprehension strategies at the college level. In R. F. Flippo & D. C. Caverly (Eds.), *Handbook of college reading and study strategy research*. Hillsdale: Erlbaum.

Rachal, K. C., Daigle, S., & Rachal, W. S. (2007). Learning problems reported by college students: Are they using learning strategies? *Journal of Instructional Psychology, 34*, 191–199.

Robinson, F. P. (1941). *Effective study*. New York: Harper & Row.

Robinson, F. P. (1962). *Effective reading*. New York: Harper & Row.

Robinson, D. H., Katayama, A., Beth, A., Odom, S., Ya-Ping, H., & Vanderveen, A. (2006). Increasing text comprehension and graphic note taking using a partial graphic organizer. *Journal of Educational Research, 100*, 103–111.

Robinson, D. H., & Kiewra, K. (1995). Visual argument: Graphic organizers are superior to outlines in improving learning from text. *Journal of Educational Psychology, 87*, 455–467.

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching students to generate questions: A review of the intervention studies. *Review of Educational Research, 2*, 181–221.

Scappaticci, E. T. (1977). A study of SQ3R and select and recite reading and study skills methods in college classes. Unpublished doctoral dissertation, Lehigh University, Bethlehem.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*(1–2), 111–139.

Spor, M., & Schneider, B. (1999). Content reading strategies: What teachers know, use, and want to learn. *Reading Research and Instruction, 38*, 221–231.

Sternberg, R. J. (1985). *Beyond IQ: A triachic theory of human intelligence*. Cambridge: Cambridge University Press.

Stull, A. T., & Mayer, R. E. (2007). Learning by doing versus learning by viewing: Three experimental comparisons of learner-generated versus author-provided graphic organizers. *Journal of Educational Psychology, 99*, 808–820.

Sung, Y. T., Chang, K. E., & Huang, J. S. (2008). Improving children's reading comprehension and use of strategies through computer-based strategy training. *Computers in Human Behavior, 24*, 1552–1571.

Tabachnick, B. G., & Fidell, L. S. (1983). *Using multivariate statistics*. Boston: Harper & Row.

Tadlock, D. F. (1978). SQ3R: Why it works, based on information processing theory of learning. *Journal of Reading, 22*, 110–112.

Titsworth, S. (2004). Students' note taking: The effects of teacher immediacy and clarity. *Communication Education, 53*, 305–320.