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Instructor and student knowledge of study strategies

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Students' self-reported study skills and beliefs are often inconsistent with empirically supported (ES) study strategies. However, little is known regarding instructors' beliefs about study skills and if such beliefs differ from those of students. In the current study, we surveyed college students' and instructors' knowledge of study strategies and had both groups evaluate the efficacy of learning strategies described in six learning scenarios. Results from the survey indicated that students frequently reported engaging in methods of studying that were not optimal for learning. Instructors' responses to the survey indicated that they endorsed a number of effective study skills but also held several beliefs inconsistent with research in learning and memory (e.g., learning styles). Further, results from the learning scenarios measure indicated that instructors were moderately more likely than students to endorse ES learning strategies. Collectively, these data suggest that instructors exhibited better knowledge of effective study skills than students, although the difference was small. We discuss several notable findings and argue for the improvement of both students' and instructors' study skill knowledge.

Keywords: Metamemory; Knowledge of memory; Study strategies; Memory beliefs; Instructor knowledge of memory.

Well over a century of research on memory (e.g., Ebbinghaus, 1885/1913) has documented methods of studying that facilitate retention and lead to durable learning (see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013, for a review). For example, two of the most effective methods of enhancing memory are spacing and testing. *Spacing* study (i.e., presentations of the same item are separated by at least one other item) typically improves memory for that item relative to *massing* study (i.e., consecutive presentations of the same item; for a review, see Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006). Memory is also enhanced when learners engage in retrieval (rather than restudy) of to-be-remembered information, a benefit known as the *testing effect* (see Rowland, 2014, for a review). Both spacing and testing enhance memory across a wide variety of learners, materials, criterion tasks and contexts, and thus qualify as 'high utility' methods (Dunlosky et al., 2013).

Despite the utility of these and other methods, surveys of college students suggest that they are often unaware of or unlikely to use optimal methods of learning (Hartwig & Dunlosky, 2012; Karpicke, Butler, & Roediger III, 2009; Kornell & Bjork, 2007; McCabe, 2011; Wissman, Rawson, & Pyc, 2012; see also Yan, Thai, & Bjork, 2014,

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for a survey of the general population). Indeed, students often report using low-utility methods of learning (Callender & McDaniel, 2009). For example, students frequently mass, or 'cram' their study before an exam, regardless of whether they know that spacing is ideal (Susser & McCabe, 2013) and regularly reread instead of testing themselves (Karpicke et al., 2009). Furthermore, students endorse other, generally ineffective, study methods such as highlighting text (Hartwig & Dunlosky, 2012).

Why do students fail to use optimal learning methods? One possibility is that time constraints, rather than conscientious planning, often drive studying (Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007). In a wide-ranging survey of 472 college students, Kornell and Bjork (2007) reported that a majority of students (59%) reported studying whatever was due soonest when asked how they decided what to study next (Table 1). Hartwig and Dunlosky (2012) replicated these findings in a survey of 324 college students, further observing a moderate, positive association between Grade Point Average (GPA) and reported use of self-testing.

A second explanation for sub-optimal learning methods is that students are simply unaware of the best study strategies. For example, McCabe (2011; Experiment 1) had 255 college students evaluate six different learning scenarios, each consisting of one empirically supported (ES) learning strategy (e.g., testing) and one strategy that was not ES (e.g., rereading). Overall, students favoured the ES strategy only 23% of the time, suggesting that they may be unaware of the most effective learning strategies. Accordingly, it is imperative that students receive accurate information regarding empirically validated methods of studying. One potential source of such information is the course instructor.

The role of the instructor

Student knowledge of study strategies is important given that, as Kornell and Bjork (2007) aptly suggest, 'Self-regulated study involves, in the main, decisions students make while they study on their own, away from a teacher's guiding hand' (p. 219). Our primary interest in this study regards the 'teacher's guiding hand'. Indeed, although this statement assumes that instructors are adequately positioned to offer evidence-based advice on studying, it remains unclear whether instructors are conversant with research on learning or whether they also exhibit the same misunderstandings as students.

To what degree are students' study strategies informed by instructors? When asked 'Would you say you study the way you do because a teacher (or teachers) taught you to study that way?' a minority of students responded 'yes' (20%, Kornell & Bjork, 2007; 36%, Hartwig & Dunlosky, 2012). These findings contrast with those of Wissman et al. (2012), who asked students to report whether '…anyone [has] ever given you advice or taught you how you should study'? When asked specifically whether advice regarding studying had ever been imparted, the majority of respondents (67%) said 'yes' and most (76%) reported that a teacher provided this advice. Thus, estimates differ as to how frequently students claim to have received advice from instructors on studying and whether they utilise that advice.

We suggest that instructors represent a 'front line' in dissemination of information about studying. Although there will be variability in the degree to which students choose to act upon this advice (or whether instructors provide such advice), it will be of little value or potentially harmful if not informed by research on learning and memory. Indeed, if instructors are not familiar with optimal study techniques, students may be better advised to improvise their methods of studying and ignore advice from instructors. Beyond their role in dissemination, instructors can implement pedagogical methods that encourage evidence-based approaches to learning. For example, frequent in-class quizzing (e.g., McDermott, Agarwal, D'Antonio, Roediger III, & McDaniel, 2014) and interleaving content (Rohrer, Dedrick, & Burgess, 2014) produce significant gains in learning when employed in the classroom. Thus, instructors who are aware of these strategies may be able to enhance student learning outcomes, regardless of student knowledge, highlighting the value of ascertaining instructors' knowledge of study skills.

The current study

Our primary goal in this study was to conduct an initial survey of instructors' knowledge of study techniques. We also collected responses from college students to facilitate comparisons between these groups. Students responded to questions

TABLE 1
Students' study survey responses

	Question	*Choices*	*Kornell and Bjork (2007)*	*Hartwig and Dunlosky (2012)*	*Present Study*
1	Would you say that you study the way you do because a teacher (or teachers) taught you to study that way?	Yes	20%	36%	36%
		No	80%	64%	64%
2	How do you decide what to study next?	Whatever's due soonest/overdue	59%	56%	63%
		Whatever I haven't studied for the longest time	4%	2%	3%
		Whatever I find interesting	4%	5%	4%
		Whatever I feel I'm doing the worst in	22%	24%	9%
		I plan my study schedule ahead of time and I study whatever I've scheduled	11%	13%	21%
3	Do you usually return to course material to review it after a course has ended?	Yes	14%	23%	28%
		No	86%	78%	72%
4	All other things being equal what do you study more for?	Essay/short answer exams	29%	20%	27%
		Multiple-choice exams	22%	22%	22%
		About the same	49%	58%	51%
		Other:	N/A	N/A	N/A
5	When you study do you typically read a textbook/article/other source material more than once?	yes, I reread whole chapters/articles	16%	19%	17%
		Yes, I reread sections that I underlined/highlighted/marked	60%	64%	58%
		Not usually	23%	17%	25%
6	If you quiz yourself while you study (either using a quiz at the end of a chapter or a practice quiz or flashcards or something else) why do you do so?	I learn more that way than I would through rereading	18%	27%	31%
		To figure out how well I have learned the information I'm studying	68%	54%	49%
		I find quizzing more enjoyable than reading	4%	10%	9%
		I usually do not quiz myself	9%	9%	12%
7	Imagine that in the course of studying you become convinced that you know the answer to a certain question (e.g., the definition of a term in psychology). What would you do?	Make sure to study (or test yourself on) it again later	36%	46%	38%
		Put it aside and focus on other material	64%	54%	62%

TABLE 1 (*Continued*)

	Question	*Choices*	*Kornell and Bjork (2007)*	*Hartwig and Dunlosky (2012)*	*Present Study*
8	What time of day do you most often do your studying?	Morning	N/A	<1%	4%
		Afternoon	N/A	11%	20%
		Evening	N/A	69%	57%
		Late night	N/A	20%	18%
9	During what time of day do you believe your studying is (or would be) most effective?	Morning	N/A	15%	17%
		Afternoon	N/A	27%	36%
		Evening	N/A	50%	40%
		Late night	N/A	9%	6%
10	Which of the following best describes your pattern of study?	I most often space out my study sessions over multiple days/weeks	N/A	47%	48%
		I most often do my studying in one session before the test	N/A	53%	52%
11	What is your current college grade point average?	0.0–1.6	N/A	0%	1%
		1.7–2.1	N/A	7%	2%
		2.2–2.6	N/A	17%	6%
		2.7–3.1	N/A	24%	22%
		3.2–3.6	N/A	36%	38%
		3.7–4.0	N/A	17%	31%
12	Which of the following study strategies do you use regularly (Please check off all that apply.)	test yourself with questions or practice problems	N/A	71%	72%
		use flashcards	N/A	62%	54%
		recopy your notes	N/A	33%	33%
		reread chapters, articles, notes, etc.	N/A	66%	67%
		make outlines underline or highlight while reading	N/A	22% 72%	53%
		make diagrams, charts, or pictures	N/A	15%	24%
		study with friends	N/A	50%	48%
		“cram” lots of information the night before the test	N/A	66%	53%
		ask questions or verbally participate during class	N/A	37%	25%
		other (Please describe:_____)	N/A	6%	4%
13	Do you believe you have a specific learning style (e.g., are you visual or verbal learner)?	Yes	N/A	N/A	58%
		No	N/A	N/A	14%
		no, I learn best through multiple methods:	N/A	N/A	28%

used in prior surveys (Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007) and an additional question created for this survey (see below). Questions for instructors came from the same sources but were adapted to reflect beliefs regarding how students should study rather than their own studying practices. For example, Question 12 (see Table 1) asked students 'Which of the following study strategies do you use regularly'? The instructor version (see Table 2, question 9) of this question asked '…which of the following study techniques do you recommend students use regularly'? In other cases, the nature of the question required an entirely different query relative to the student version. For example, whereas students were asked whether their methods of studying were imparted by an instructor (Table 1, question 1), instructors were asked whether they discussed study techniques in class (Table 2, question 1).

In addition to using the surveys administered by Hartwig and Dunlosky (2012) and Kornell and Bjork (2007), we added a question regarding learning styles (i.e., the notion that individuals possess inherent differences in how they learn, such as the visual or verbal learner, which should be matched to the method of instruction). The concept of learning styles appears to have great traction in education despite little or no evidence for its utility (e.g., Kirschner & van Merriënboer, 2013; Moran, 1991; Pashler, McDaniel, Rohrer, & Bjork, 2008). Students were asked whether they had a specific learning style (see Table 1, question 13), whereas instructors were asked about the existence of learning styles (see Table 2, question 13). Instructors who endorsed learning styles were further asked whether their teaching accommodated variations in learning styles (question 14). Our interest was in whether a belief in learning styles was pervasive among college students and instructors.

Because survey questions for instructors and students differed in some respects, we were able to identify broad similarities and differences in knowledge of study strategies but could not make the direct comparisons that would be possible if all participants responded to the same questions. In order to address this issue, we employed the methodology reported by McCabe (2011) and had all participants (both students and instructors) rate six learning scenarios, each of which described a strategy that was or was not ES. These ratings permitted direct comparisons between groups and provided an additional method of assessing student and instructor knowledge of study techniques.

METHODS

Participants

Three hundred students (227 females) and 146 instructors at Colorado State University were surveyed. Students were undergraduates enrolled in introductory psychology courses who participated for course credit. The majority of students were freshmen (58%) or sophomores (24%), with the remainder comprised of juniors (12%), seniors (6%) and a single graduate student. Psychology was the most frequently represented major (23%). Including psychology, science-based majors (e.g., biology, chemistry) comprised the majority of the respondents (67%). Approximately 19% of all students had a liberal arts (e.g., literature, history) or business major, 10% were undecided, and the remaining students majored in engineering (4%).

Characteristics of the instructors surveyed are presented in Table 3. The majority of instructors (70%) reported teaching 10 years or less and most taught courses in a science or liberal arts curriculum. The vast majority of instructors reported teaching undergraduate courses (90%), whereas approximately half reported teaching graduate courses (52%).[1] A slim majority (51%) of the instructors were tenure-track faculty, with the remaining instructors consisting of special teaching faculty, graduate student instructors and academic advisors, amongst others.

Materials

Student surveys. Survey questions administered to students can be found in Table 1. Questions 1–7 were taken from Kornell and Bjork (2007) and questions 8–12 were taken from Hartwig and Dunlosky (2012).[2] The final question regarding learning styles was added specifically for this study.

[1] Note that the aggregate of these values will exceed 100% given that instructors may teach courses at the undergraduate and graduate level.

[2] Due to an experimenter error, one question on the student and instructor survey did not mimic Hartwig and Dunlosky (2012). Specifically, for question 15, Hartwig and Dunlosky asked, in part, whether students endorsed either of these strategies: 'make outlines', 'underline or highlight while reading'. Our survey mistakenly conjoined these options such that participants were asked if they 'make outlines, underline or highlight while reading'.

TABLE 2
Instructors' survey responses

	Question	*Choices*	*Percentage*
1	Do you discuss study techniques in class?	Yes	79%
		No	21%
2	If yes, how often do you discuss study techniques?	A few times a week	3%
		About once a week	23%
		Before tests/major assignments	46%
		About once every semester	15%
		Other	17%
3	What testing format do you use the most often?	Essay/short answer exams	39%
		Multiple-choice exams	16%
		About the same	23%
		Other	22%
4	Why do you use this format?	Ease, simplicity of grading	32%
		Ease, simplicity of item construction	10%
		Captures key constructs from class	60%
		Encourages better student learning	57%
		Other	17%
5	How do you think your students choose to study?	Whatever's due soonest/overdue	86%
		Whatever they haven't studied for the longest time	2%
		Whatever they find interesting	4%
		Whatever they feel they're doing the worst in	4%
		They plan their study schedule ahead of time and I study whatever they have scheduled	4%
6	How do you think your students *should* choose to study?	Whatever's due soonest/overdue	3%
		Whatever they haven't studied for the longest time	3%
		Whatever they find interesting	13%
		Whatever they feel they're doing the worst in	10%
		They plan their study schedule ahead of time and I study whatever they have scheduled	72%
7	Do you return to earlier material in later sections? (e.g., reviewing week 1 material near the middle of the semester)	Yes	80%
		No	20%
8	Do you recommend study techniques to students, either in class or during out of class meetings?	Yes	86%
		No	14%
9	If yes, which of the following study techniques do you recommend students use regularly? (please check off all that apply)	Test yourself with questions or practice problems	65%
		Use flashcards	25%
		Recopy your notes	18%
		Reread chapters, articles, notes, etc.	41%
		Make outlines underline or highlight while reading	42%
		Make diagrams, charts or pictures	34%
		Study with friends	59%
		'cram' lots of information the night before the test	0%
		Ask questions or verbally participate during class	62%
		Other (Please describe:_____)	15%
10	If you do discuss techniques in class, do you think students use those techniques?	Yes	28%
		Yes for my class, but not necessarily for others	40%
		No	16%
		Some do, some do not	16%
11	If you think students should quiz themselves (either using a quiz at the end of a chapter, a practice quiz, flashcards or something else), why should they do so?	They will learn more that way than through rereading	19%
		To figure out how well they have learned the information they're studying	68%
		I do not think quizzing will necessarily benefit students	12%

TABLE 2 (*Continued*)

	Question	*Choices*	*Percentage*
12	Do you use/encourage spacing techniques in class? (e.g., leaving days/weeks for students to study for the next exam or returning to information after discussing it)	Yes	61%
		No	39%
13	Do you believe students have different learning styles (e.g., visual vs. auditory learners)?	Yes	91%
		No	9%
14	If yes, do you teach to accommodate those differences?	Yes	77%
		No	16%
		I did not say 'yes'	7%

Instructor surveys. Survey questions administered to instructors were adapted from previous survey items (Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007; see Table 2) to reflect instructors' opinions about studying rather than personal study habits. Questions 13–14 were added to assess instructors' beliefs about learning styles.

TABLE 3
Descriptive statistics of the instructors sampled

Variable	*N*	*Percentage*
Number of years teaching		
0–5 years	73	49.66%
6–10 years	30	20.41%
11–15 years	22	14.97%
16–20 years	8	5.44%
21+years	14	9.52%
Subject area		
Science	88	59.86%
Liberal arts	45	30.61%
Business	5	3.40%
Engineering	5	3.40%
Other[a]	4	8.16%
Level taught		
Undergraduate	133	90.48%
Graduate	76	52.05%
Other[b]	2	1.38%
Position		
Professor	17	11.56%
Associate professor	35	23.81%
Assistant professor	24	16.33%
Adjunct instructor	31	21.09%
Graduate teaching assistant	24	16.33%
Academic adviser	9	6.12%
Other[c]	7	4.76%

[a]Listed seminars or classes in the honours programme and residential communities without specifying the course topic; [b]Teaching in a community outreach programme or pre-university language learning; [c]Special instructors with a dedicated teaching position (n = 3), postdoctoral instructors (n = 2), and emeritus faculty who did not specify a rank (n = 2).

Learning scenarios. Six learning scenarios, primarily taken from McCabe (2011),[3] were administered to all participants (see Appendix A). Each scenario described two strategies, one empirically validated and one that was not. For example, a question about spacing asked the following:

> Two students are studying for an exam. Student A studies all material for the unit the two days leading up to the exam. Student B starts studying two weeks before the exam, studying a little bit every day. Both students spend the same total amount of hours studying.

After reading the scenario, participants rated the value of the strategies used by Student A and Student B on a scale from 1 (*not at all beneficial to learning*) to 7 (*very beneficial to learning*). The remaining scenarios pitted the value of generating versus being given information (Slamecka & Graf, 1978), of interleaving versus blocking learning (Kornell & Bjork, 2008; Rohrer & Taylor, 2007), of static versus animated images (Mayer, Hegarty, Mayer, & Campbell, 2005), of testing versus restudying (Roediger & Karpicke, 2006) and of including or excluding irrelevant but interesting details (Mayer, Griffith, Jurkowitz, & Rothman, 2008).

Procedure

Participants were told that they would be participating in a survey that sought a better understanding of how students typically study and instructors' role in student study techniques. Participants

[3]We thank Jennifer McCabe for providing us with these materials.

were provided a link to the appropriate survey (instructor or student) and completed the survey and learning scenario questions at their convenience. Several survey questions, particularly those that allowed an 'Other' response, permitted participants to elaborate on their answers.

The order of survey and learning scenario questions was randomised by type (survey, learning scenario) so as to control for any potential carryover effects due to completing one instrument before the other. Therefore, 160 students and 70 instructors completed the survey questions first, whereas 140 students and 76 instructors completed the learning scenarios first.[4]

RESULTS

Although our primary interest was in instructors' responses, we first report students' responses so as to assess consistency with prior surveys (Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007; see Table 1). We then consider instructors' responses to the surveys, and directly compare student and instructor answers for the learning scenario questions. The alpha level was set to .05 for all statistical tests reported.

Survey results

Students. Overall, a high level of consistency was apparent between our survey and prior surveys, with few questions resulting in differences of more than 15% points among the surveys. We highlight several notable responses. First, although students in all three surveys generally answered in the negative when asked whether their method of studying was the result of instruction from a teacher (question 1), a greater percentage reported using a strategy suggested by a teacher in our survey (36%, replicating Hartwig & Dunlosky, 2012) than found by Kornell and Bjork (20%; 2007). The majority of our respondents also reported prioritising whatever was due soonest when selecting what to study (63%; question 2) and only 31% regarded quizzing as a method that enhanced learning (question 6). Further, the percentage of students reporting spacing versus massing their study was split nearly evenly (48%; question 10), again replicating Hartwig and Dunlosky (47%; 2012).

Question 12 asked students to endorse any of a variety of strategies used while studying, of which the most commonly endorsed were: testing (72%), rereading material (67%), and using flashcards (54%). Thus, our results aligned well with those of Hartwig and Dunlosky (2012), with the exception that our students were somewhat less likely to report participating during class (25% vs. 37%) or cramming (53% vs. 66%). Question 13 was unique to our study and asked students whether they had a particular learning style. The majority of students (58%) claimed to have a particular learning style, with the remainder suggesting that learning was best through multiple methods (28%) or that they had no learning style (14%).

As in Hartwig and Dunlosky (2012), we assessed the relationship between students' self-reported GPA and their endorsement of evidence-based strategies (e.g., testing, spacing). Participants were identified as either endorsing a strategy (1) or not (0) and the association with GPA was examined via gamma correlations. Gamma is a non-parametric index of association that ranges from −1.0 to +1.0. Positive values of gamma indicate that higher GPAs were associated with a greater likelihood of endorsing evidence-based strategies. Our analyses suggested a moderate, marginally reliable relationship between GPA and endorsing testing (G = 0.175, p = .084), and use of flashcards (G = −0.157, p = .077). The relationship between GPA and endorsement of spacing was not reliable (G = 0.045, p = .612).

Instructors. Instructor responses to survey questions can be found in Table 2 and a summary of free responses to questions initially marked 'Other' can be found in Appendix B. The majority of instructors (79%; question 1) reported discussing study techniques in class and many (68%; question 10) believed that students heeded this advice, even if only in their class. Most instructors advocated a planned schedule of studying (72%; question 6) but only a handful (4%; question 5) believed that students put this into practice. Instead, the modal belief (86%) was that students' study whatever is due soonest, consistent with students' self-reports.

Overall, instructors primarily endorsed techniques known to promote retention. In particular, the majority (61%; question 12) reported

[4] Order had no influence on responses for either students or instructors.

encouraging spacing and putting spacing into practice during class sessions (80%; question 7). Sixty-five percent (question 9) reported that they were likely to recommend self-testing as a method of study. Instructors primarily endorsed self-testing as a method of determining what had been learned rather than as a method of studying that fostered superior retention relative to rereading (68% vs. 19%; question 11).

Instructors also endorsed some methods that do not have a strong evidential basis for enhancing learning. For example, 40% of instructors advocated rereading (question 10) and there appeared to be some consensus that it was advantageous to study in groups (59%; question 10), despite mixed evidence on learning within social settings (Rajaram, 2011). Most notably, 91% (question 13) of instructors believed that students have different learning styles with the majority subsequently reporting teaching in a manner that would accommodate those styles (77%; question 14).

Was the number of years of teaching experience related to the strategies instructors endorsed? We examined this question by calculating gamma correlations between the number of self-reported years of teaching and strategy endorsement. Overall, the relationship between years of teaching and the strategies endorsed was modest and not reliable, with one exception. Specifically, there was a positive correlation between years of experience and views on testing ($G = 0.246$; $p = .017$), such that more experienced instructors were more likely to advocate testing as a study strategy. There was a marginally significant, negative relationship between experience and self-reported use of spacing techniques in class ($G = -0.172$; $p = .084$), such that more experienced instructors were less likely to report encouraging spacing techniques. Experience was unrelated to whether study techniques were discussed in class ($G = 0.150$; $p = .204$) or a belief in learning styles ($G = -0.097$; $p = .539$).

Scenario question results

As noted previously, results from the surveys do not permit direct comparisons between students and instructors because the nature of the questions differ for respondents asked how they study (students) versus how they would recommend studying (instructors). Answers to learning scenario questions do permit such direct comparisons as both groups were charged with making the same evaluations for the same questions. A rating of four for each scenario indicates a neutral evaluation (i.e., the strategy is neither effective nor ineffective), ratings above four indicate that the strategy was deemed effective and ratings below four indicate that the strategy was deemed ineffective.

Table 4 shows mean ratings for the ES option and the option not ES for students (upper panel) and instructors (lower panel). On the far right is a statistical comparison (paired samples *t*-test) between the two options for each scenario and the resulting effect size. First, for students, only the spacing scenario yielded a higher rating for the ES option relative to the alternative, with this difference characterised by a large effect size ($d = 1.03$). Otherwise, students regarded interesting but irrelevant details, animated media and blocking as superior for learning compared with each of the ES options. The magnitude of these misunderstandings were large (*d*s ranged from −0.74 to −1.60). The remaining two scenarios demonstrated that participants provided numerically higher ratings to the ES scenario, but this was characterised by either no reliable difference in ratings (generation) or a marginal difference in ratings (testing).

A largely similar pattern of ratings for the six scenarios was evident for instructors. Like students, they provided higher ratings for the ES option for generation and testing, but for instructors this rating was reliably greater relative to the rating for the option that was not supported and was characterised by medium effect sizes ($d = 0.85$ and 0.61 for generation and testing, respectively). In addition, instructors mimicked students in providing a reliably higher rating for spacing compared with massing that yielded a large effect size ($d = 1.43$). Instructors also favoured irrelevant details, animated media and blocking relative to the ES option, with these misunderstandings characterised by medium to large effect sizes (*d*s ranged from −0.75 to −1.48).

Thus, although instructors were more likely to value testing and generation over the option that was not ES, their ratings generally reflected a similar pattern to students both in regard to effective strategies (spacing) and in favouring ineffective strategies (e.g., blocking). Confirmation of this pattern can be found in Table 5, which lists the percentage of cases (for instructors and students) for which the ES option was given a

TABLE 4
Mean ratings (and standard deviations) of ratings for ES option and the option that is not ES (non-ES option) for the learning scenario questions for students (upper panel) and instructors (lower panel)

Students						
	ES option		*Non-ES option*		*Comparison*	
Scenario	*M*	*SD*	*M*	*SD*	*t*[a]	*Cohen's d*[b]
Generation	5.16	1.68	5.07	1.49	0.68	0.06
Low interest details	3.56	1.59	5.30	1.71	11.01**	−1.05
Static media	4.36	1.50	5.47	1.51	8.35**	−0.74
Testing	4.61	1.71	4.32	1.76	1.90*	0.17
Interleaving	3.13	1.17	5.70	1.50	16.75**	−1.60
Spacing	5.68	1.58	4.08	1.51	11.23**	1.03
Instructors						
	ES option		*Non-ES option*		*Comparison*	
Scenario	*M*	*SD*	*M*	*SD*	*t*[a]	*Cohen's d*[b]
Generation	5.77	1.30	4.72	1.17	6.99**	0.85
Low interest details	3.45	1.40	5.37	1.47	11.89**	−1.34
Static media	4.39	1.10	5.31	1.34	5.89**	−0.75
Testing	4.76	1.65	3.78	1.55	5.35**	0.61
Interleaving	3.43	1.44	5.49	1.35	10.46**	−1.48
Spacing	5.89	1.23	4.02	1.39	11.10**	1.43

Positive values indicate that the ES option is rated is more beneficial than the option that is not ES.
[a]Paired samples *t*-test comparing ratings to each option for each scenario; [b]Effect size estimate comparing responses to the ES and non-ES option.
*$p < .10$; **$p < .01$.

TABLE 5
Mean percentage of students and instructors providing a higher rating for the ES scenario than the scenario that is not ES

	Percentage[a]		*Comparison*	
Scenario	*Students*	*Instructors*	X^{2}[b]	*Cohen's d*[c]
Generation	52%	75%	21.52**	−0.58
Low interest details	19%	8%	8.57**	0.54
Static media	20%	14%	2.11	0.23
Testing	49%	62%	6.55*	−0.30
Interleaving	16%	13%	1.20	0.10
Spacing	69%	74%	1.06	−0.13

Positive values indicate that students were more likely to provide a higher rating for the ES option than instructors. Effect sizes were calculated by converting to *Cohen's d* from an adjusted natural log odds ratio (see Borenstein, 2009; Fleiss & Berlin, 2009, for details of the calculation and conversion).
[a]The percentage of participants providing a higher rating for the ES scenario than the scenario that is not ES; [b]Chi-square test of the distribution of responses reflects higher ratings for the ES scenario; [c]Effect size estimates comparing students and instructors.
*$p < .05$; **$p < .01$.

higher rating than the option that was not supported.[5] As can be seen, instructors were more likely than students to favour generation and testing relative to the option that was not ES. A single reliable difference was evident in favour of students (they were less likely to favour interesting details) but near-floor levels of performance for instructors suggests some caution in this conclusion. Otherwise, students and instructors exhibited similar distributions of responses in regard to static media, interleaving and spacing. Indeed, an analysis of global performance (i.e., the mean percentage of scenarios for which participants provided a higher rating for the ES option relative to the option that was not supported) showed that instructors (41%) exhibited

[5]For each scenario question, each individual participant was coded as 1 if the empirically supported scenario was given a higher rating than the alternative and a 0 if the alternative rating was given a higher rating than the empirically supported scenario. The distribution of responses was then examined via a chi-square test.

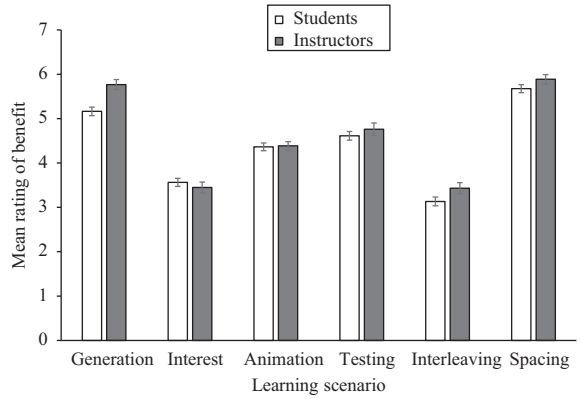

Figure 1. Mean rating of benefit given to the ES option for each scenario for students (white bars) and instructors (grey bars). Error bars represent the standard error of the mean.

a marginal advantage over students (37%), $t(432) = 1.90$, $p = .06$, $d = 0.20$.

As an additional means of directly comparing instructors and students, we examined the degree to which mean ratings differed for the ES option for each scenario (see Figure 1). Students' and instructors' mean ratings differed reliably for generation, with instructors providing a higher mean rating than students regarding the value of generating one's own strategy, $t(432) = 3.69$, $p < .001$, $d = 0.38$. Instructors also provided a marginally higher mean rating for interleaving compared with students, $t(432) = 1.76$, $p = .08$, $d = 0.18$. No other comparisons were reliable (ts < 1.37, ps $> .17$, ds < 0.14). In addition to examining each individual scenario, we also assessed global performance by calculating the percentage of ES strategies that were given a rating of five or above (i.e., the strategy was rated as at least somewhat beneficial) by participants. Overall, instructors (54%) were more likely to endorse the ES outcome than students (48%), $t(432) = 2.38$, $p = .018$, $d = 0.25$. Thus, instructors demonstrated better knowledge of learning strategies than students, but the aggregate advantage was small.

GENERAL DISCUSSION

Previous studies have examined students' beliefs, habits and knowledge of strategies that promote effective learning (Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007; McCabe, 2011). This prior work generally suggests that students have difficulty identifying optimal methods of learning (McCabe, 2011) and often report engaging in methods of studying (e.g., rereading) that are less effective than other strategies available (e.g., testing). What remains unclear is whether such deficiencies in knowledge of studying are also apparent in instructors. Accordingly, in the current study we assessed instructors' knowledge of study skills and their recommendations for studying in comparison with a group of students. Our findings suggest that instructors' knowledge of study skills exceeded those of the student respondents but that this advantage was generally not large.

Responses to the survey indicated several notable points of consistency between instructors' recommendations for studying and students' self-reported practices. For example, instructors (65%) and students (72%) both frequently endorsed the value of testing as a study strategy and both groups were most likely to deem it a method of determining what had been learned (with instructors more likely to negate the learning that also occurs). As well, nearly half of the students reported spacing (48%) while most instructors indicated that they encouraged spacing in class (61%). The majority of respondents in both groups endorsed learning styles, although this was far more prevalent among instructors (91%) than students (58%). Moreover, instructors appeared to have some sense of students' actual study habits. For example, most (86%) believed that students studied what was due soonest, consistent with students' self-reports.

Several significant discrepancies were also apparent. Foremost, whereas a minority of students (36%) claimed that their study techniques did not emanate from an instructor, most instructors (79%) reported discussing study techniques in class. Such self-reports underscore the value of ascertaining instructors' self-reported classroom practices but also leave open the question of whether students heed the advice proffered. Given that asking a broader question appears to increase the chance the students report using a study technique suggested by a teacher, this may reflect the particular question used (Wissman et al., 2012). Instructors (62%) were more enthusiastic about the value of participating in class than students (25%), but less enthusiastic about the value of flashcards (25% of instructors recommended them) than students (54% favoured this strategy). As well, a majority of students (53%) reported cramming frequently, whereas not a single instructor regarded cramming as a viable strategy.

Although informative, direct comparisons are difficult given that students reported studying

behaviours whereas instructors were queried about their recommendations for studying. Thus, learning scenario measures were included to provide more direct comparisons. On a global level, both groups provided higher ratings to the ES scenario relative to the alternate option less than half of the time. Instructors exhibited a marginal advantage over students (d = 0.20) that was confined to generation and testing. A slim difference between students and instructors was also evident for mean ratings of the ES option (see Figure 1), where a reliable difference was apparent only for generation. Both groups similarly overestimated the value of high-interest details and both groups appeared unaware of the benefits of interleaving.

Accordingly, our results suggest that instructors and students have modest knowledge of optimal study strategies and differ little in this regard. What accounts for the substantial overlap in responses? We suggest two potential sources. First, students and instructors may be sampling from a common pool of information and misinformation about memory that creates a self-sustaining cycle (cf. Simons & Chabris, 2011). For example, instructors were once students who had received evidence-based (as well as more questionable) information from their instructors and may have, in turn, passed this information on to their students.[6] Alternatively, participants' ratings may reflect strategies that are not regarded as optimal but which can be effective at times. For example, although spacing consistently results in superior retention relative to massing (see Cepeda et al., 2006, for a comprehensive review), a massing strategy can yield high levels of learning, particularly in the short-term (e.g., Roediger & Karpicke, 2006). Thus, responses may not reflect misunderstandings as much as successful applications of less optimal strategies when an ES comparison was not available. Moreover, the questions used may engender interpretations that differ from the cardinal construct. For example, participants may not have interpreted our query about learning styles to signify a preferred method of learning that is insensitive to specific content, perhaps regarding different methods of instruction as appropriate for different types of material (e.g., math vs. literature). If instructors viewed the question about learning styles in this manner, their responses may reflect the need to adapt teaching to different content rather than a belief that students possess invariant learning styles.

We do note several other caveats in regard to our conclusions. For example, as with any survey, our data reflect self-reported beliefs that have unknown levels of fidelity with actual study behaviours. As well, a self-selection bias may be evident such that only those instructors with high levels of knowledge or interest in studying chose to complete the survey. This would argue that scores would be inflated and, thus, we may overestimate instructors' true level of knowledge of study strategies. Future work with different samples will provide some indication of the generality of our findings.

Summary and conclusions

Overall, our data suggest high levels of consistency among students' and instructors' views on studying. This is apparent in beliefs with little evidential basis (e.g., learning styles, that blocking is superior to interleaving, quizzing is solely a means of determining the accuracy of a response) and those that qualify as optimal methods of studying (e.g., spacing, testing). Instructors exhibited a small advantage over students but, if they are key sources of knowledge about studying, their need for an accurate understanding of memory may be even greater. Accordingly, although we agree with Kornell and Bjork (2007) that studying frequently occurs away from the 'guiding hand' of the instructor, we suggest that enhancing instructor knowledge of studying also has an important role to play in optimising student learning.

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REFERENCES

Borenstein, M. (2009). Effect sizes for continuous data. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis* (2nd ed., pp. 221–235). New York, NY: Russell Sage Foundation.

Callender, A. A., & McDaniel, M. A. (2009). The limited benefits of rereading educational texts. *Contemporary Educational Psychology*, *34*(1), 30–41. doi:10.1016/j.cedpsych.2008.07.001

Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin*, *132*, 354–380. doi:10.1037/0033-2909.132.3.354

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest*, *14*, 4–58. doi:10.1177/1529100612453266

Ebbinghaus, H. (1885/1913). *Memory*: *A contribution to experimental psychology*. (Henry A. Ruger & Clara E. Bussenius, Trans.). New York, NY: Teachers College, Columbia University.

Fleiss, J. L., & Berlin, J. A. (2009). Effect sizes for dichotomous outcomes. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis* (pp. 237–253). New York, NY: Russell Sage Foundation.

Hartwig, M. K., & Dunlosky, J. (2012). Study strategies of college students: Are self-testing and scheduling related to achievement? *Psychonomic Bulletin & Review*, *19*(1), 126–134. doi:10.3758/s13423-011-0181-y

Karpicke, J. D., Butler, A. C., & Roediger III, H. L. (2009). Metacognitive strategies in student learning: Do students practise retrieval when they study on their own? *Memory*, *17*, 471–479. doi:10.1080/09658210802647009

Kirschner, P. A., & van Merriënboer, J. J. G. (2013). Do learners really know best? Urban legends in education. *Educational Psychologist*, *48*, 169–183. doi:10.1080/00461520.2013.804395

Kornell, N., & Bjork, R. A. (2007). The promise and perils of self-regulated study. *Psychonomic Bulletin & Review*, *14*, 219–224. doi:10.3758/BF03194055

Kornell, N., & Bjork, R. A. (2008). Learning concepts and categories: Is spacing the "enemy of induction"? *Psychological Science*, *19*, 585–592. doi:10.1111/j.1467-9280.2008.02127.x

Mayer, R. E., Griffith, E., Jurkowitz, I. T. N., & Rothman, D. (2008). Increased interestingness of extraneous details in a multimedia science presentation leads to decreased learning. *Journal of Experimental Psychology: Applied*, *14*, 329–339.

Mayer, R. E., Hegarty, M., Mayer, S., & Campbell, J. (2005). When static media promote active learning: Annotated illustrations versus narrated animations in multimedia instruction. *Journal of Experimental Psychology: Applied*, *11*, 256–265.

McCabe, J. (2011). Metacognitive awareness of learning strategies in undergraduates. *Memory & Cognition*, *39*, 462–476. doi:10.3758/s13421-010-0035-2

McDermott, K. B., Agarwal, P. K., D'Antonio, L., Roediger III, H. L., & McDaniel, M. A. (2014). Both multiple-choice and short-answer quizzes enhance later exam performance in middle and high school classes. *Journal of Experimental Psychology: Applied*, *20*, 3–21. doi:10.1037/xap0000004

Moran, A. (1991). What can learning styles research learn from cognitive psychology? *Educational Psychology*, *11*, 239–245. doi:10.1080/0144341910110303

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles concepts and evidence. *Psychological Science in the Public Interest*, *9*, 105–119.

Rajaram, S. (2011). Collaboration both hurts and helps memory: A cognitive perspective. *Current Directions in Psychological Science*, *20*(2), 76–81. doi:10.1177/0963721411403251

Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning taking memory tests improves long-term retention. *Psychological Science*, *17*, 249–255. doi:10.1111/j.1467-9280.2006.01693.x

Rohrer, D., Dedrick, R. F., & Burgess, K. (2014). The benefit of interleaved mathematics practice is not limited to superficially similar kinds of problems. *Psychonomic Bulletin & Review*, *21*, 1323–1330. doi:10.3758/s13423-014-0588-3

Rohrer, D., & Taylor, K. (2007). The shuffling of mathematics problems improves learning. *Instructional Science*, *35*, 481–498. doi:10.1007/s11251-007-9015-8

Rowland, C. A. (2014). The effect of testing versus restudy on retention: A meta-analytic review of the testing effect. *Psychological Bulletin*, *140*, 1432–1463. doi:10.1037/a0037559

Simons, D. J., & Chabris, C. F. (2011). What people believe about how memory works: A representative survey of the US population. *PLoS One*, *6*, e22757.

Slamecka, N. J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Human Learning and Memory*, *4*, 592–604. doi:10.1037/0278-7393.4.6.592

Susser, J. A., & McCabe, J. (2013). From the lab to the dorm room: Metacognitive awareness and use of spaced study. *Instructional Science*, *41*, 345–363. doi:10.1007/s11251-012-9231-8

Wissman, K. T., Rawson, K. A., & Pyc, M. A. (2012). How and when do students use flashcards. *Memory*, *20*, 568–579. doi:10.1080/09658211.2012.687052

Yan, V. X., Thai, K.-P., & Bjork, R. A. (2014). Habits and beliefs that guide self-regulated learning: Do they vary with mindset? *Journal of Applied Research in Memory and Cognition*, *3*, 140–152. doi:10.1016/j.jarmac.2014.04.003

APPENDIX A. Learning scenarios used in the survey

Generation

Two assignments ask students to learn the list of cranial nerves using a mnemonic device. Assignment A includes a commonly used mnemonic device provided by the instructor to assist students in their learning. Assignment B asks students to create their own mnemonic device to assist their learning. After two weeks, all students are asked to list the cranial nerves in order.

Low versus high interest details

Two multimedia slideshows present information about the same scientific topic. Both slideshows include information directly relevant to the topic, plus extra details that are not relevant for the subsequent test. The irrelevant extra details in Slideshow A have a high interest level for college students. The irrelevant extra details in Slideshow B have a low interest level for college students. After studying the materials, a test is given that asks how the topic can be applied to new situations.

Static versus animated images

Two presentations describe information about the same scientific topic. Presentation A is paper-based, and includes static (i.e., still) illustrations along with printed text. Presentation B is computer-based, and includes animated (i.e., video) illustrations. After studying the materials, a test is given that asks for a written explanation of the scientific principle, and also how the topic can be applied to new situations.

Testing versus rereading

In two different classes, a 275-word prose passage about a specific topic is presented. In Class A, students first study the passage for seven minutes, and then are asked to write down from memory as much of the material from the passage as they can. In Class B, students first study the passage for seven minutes, and then are asked to study the passage again for another seven minutes. After one week, all students are asked to recall as much of the passage as they can remember.

Interleaving versus blocking

Two art history professors present 6 paintings by each of 12 artists (72 paintings total). Professor A presents all six paintings by a single artist consecutively (i.e., grouped), and then moves on to the next artist's six paintings, and so on, until all paintings have been presented. Professor B presents the various artists' paintings in an intermingled fashion (i.e., mixed), such that a single painting by a particular artist would be followed by a different artists.

Spacing versus massing

Two students are studying for an exam. Student A studies the two days leading up to the exam. Student B starts studying two weeks before the exam, studying a little bit everyday. Both students spend the same total about of hours.

APPENDIX B. Summary of instructors' free responses when choosing 'other'

	Instructor questions	*Choices*	*Percentage*
2	If yes, how often do you discuss study techniques?	Multiple times a semester	63%
		Beginning of semester	11%
		Before/after exams	16%
		Whenever students come to office/ask in class (student prompted)	11%
3	What testing format do you use the most often?	Another type of production test (e.g., fill-in-the-blanks, interviews, essay)	9%
		Another type of recognition test (e.g., true-false, matching)	3%
		Problem solving (e.g., math, chemistry)	16%
		Unspecified mix of recognition/production questions	41%
		Do not administer exams/quizzes	28%
		Not specified	3%
4	Why do you use this format?	Identify how well students have learned	26%
		Multiple formats to meet different needs	37%
		Covers more material at once	5%
		No exams/don't write exams	16%
		Other	16%
9	If yes, which of the/following study techniques do you recommend students use regularly?	Active learning (e.g., practice, create study guides)	48%
		Differs by student	14%
		Feedback	5%
		Using office hours	14%
		Spacing/distributing study	5%
		Study without distractions	5%
		Not specified	10%