

THESIS

VETERINARY SCHOOL INSTRUCTOR KNOWLEDGE AND USE OF STUDY
STRATEGIES

Submitted by

Rebecca M. Osborn

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Summer 2024

Master's Committee:

Advisor: Matthew Rhodes

Anne Cleary

Sara Anne Tompkins

Meena Balgopal

Copyright by Rebecca Marie Osborn 2024

All Rights Reserved

ABSTRACT

VETERINARY SCHOOL INSTRUCTOR KNOWLEDGE AND USE OF STUDY STRATEGIES

Empirically supported study strategies have been investigated for years and there has been a growing body of research on what strategies undergraduate students know of and utilize while studying. However, there is less research on instructor knowledge and endorsement of study strategies as they can serve as a guide to students in how to study. Professional schools (e.g., medical, pharmacy, or veterinary schools) have little to no research evaluating what strategies instructors encourage to students while the population of students are meant to be lifelong learners. In the current study, instructors in veterinary medicine were surveyed on their knowledge and endorsement of study strategies including learning scenarios where participants rated strategy effectiveness. The endorsement of study strategies was also correlated with the ranking and acceptance rate of the veterinary school the instructor teaches at to determine if there is a relationship of empirically supported study strategies and the ranking of school quality. The survey found that instructors endorsed both beneficial and nonbeneficial study strategies and learning scenarios but were more likely to encourage empirically supported strategies to students. The ranking and acceptance rate of the school showed no correlation with more endorsement of those beneficial strategies. The results of this survey demonstrate veterinary instructors have a slight preference for empirically supported learning strategies but continue to hold some misconceptions on learning. Further research is needed to determine how best to reach

and inform this instructor population, but veterinary instructors are highly motivated to learn more about how best to teach veterinary students.

ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Matthew Rhodes, for his willingness to take me in as a graduate student and to provide me with guidance and grace even when I took time away from school. His support and encouragement allowed me to take a unique approach to my research project that will best serve me in my career ahead. I could not be more thankful for him as my advisor. I would also like to thank Dr. Anne Cleary, Dr. Meena Balgopal, and Dr. Sara Anne Tompkins for serving as my committee members and allowing great questions and discussion from this research project.

TABLE OF CONTENTS

ABSTRACT..... ii
ACKNOWLEDGMENTS iv
Introduction..... 1
 Empirically Supported Study Strategies 1
 Student Utilization of Effective Study Strategies 3
 Beyond Undergraduate Students..... 5
 Study Strategy Interventions..... 7
 Instructors’ Role in Guiding Study 10
 Current Study 13
Methods..... 15
 Participants..... 15
 Materials 15
 Instructor Surveys and Learning Scenarios 15
 Procedure 16
 Scoring and Analysis..... 16
 Participant Removal..... 17
Results..... 18
 Participant Characteristics 18
 Survey Results 18
 Influence of Order..... 21
 Scenario Results..... 22
General Discussion 27
 Key Results: Survey..... 27
 Key Results: Learning Scenario Comparisons 29
 Implications and Caveats 29
 Conclusion 30
References..... 32
Appendices..... 40
 Appendix A. Survey Questions for Instructors 40
 Appendix B. Summary of Instructors’ Free Response..... 46

INTRODUCTION

Students often use strategies that either feel best while learning or base their strategies on how someone taught them to study. Researchers have been investigating those strategies that students use and identifying what research indicates the most effective learning techniques. Although these strategies have been identified, there has been continuous work in the past decades to transfer those empirically supported strategies into use (Dunlosky et al., 2013; Rhodes et al., 2020). Given that the transfer of information from researcher to student is not always widespread, a more practical approach may be informing the instructor, who may then share the strategies with students (Krueger et al., 2023). Indeed, while the focus of research has been on the undergraduate student population (Blasiman et al., 2017), with some focus on instructors at that level (Morehead et al., 2016; Piza et al., 2019), much less research has surveyed instructors at professional schools (e.g., medical school, dental school) and no prior work has included veterinary schools. The current study bridges that gap between veterinary school instructors and identifies what study strategies they endorse, providing greater understanding of STEM instructors' knowledge of and approach to learning.

Empirically Supported Study Strategies

Several effective learning strategies have been identified through research. As one example of an effective learning strategy, the testing effect, is the finding that retrieving information from memory results in better long-term memory of that material than restudying or rereading that same information. For instance, Roediger and Karpicke (2006) explored participants' memory for a scientific passage after reading and testing or re-reading prose passages. Participants were given a final recall test either 5 minutes, 2 days, or 1 week after the

initial reading. Results on the delayed tests indicated that there was much greater retention and less forgetting of the information from the passage if the participant had tested rather than re-read. Studies throughout the 20th century found similar benefits of retrieving information rather than re-exposure (Abbott, 1909; Foos & Fisher, 1988; Spitzer, 1939) but, in recent decades, research has expanded considerably. Rowland's (2014) meta-analysis of 159 studies primarily in the laboratory found a robust benefit of testing over restudy ($g = 0.50$) in support of the testing effect. Yang et al.'s (2021) meta-analysis of 222 classroom studies of the testing effect (via quizzes) similarly found an overall benefit of testing of $g = 0.50$, suggesting a medium effect of practice testing compared with other learning strategies.

The order in which participants are exposed to information has also been found to impact later memory for that material. For instance, information is blocked together if items are studied consecutively (*dog, dog, house, house, key, key*), whereas items that are studied in interleaved fashion are mixed together (*dog, house, key, dog, house, key*; Zechmeister & Shaughnessy, 1980). Kornell and Bjork (2008) had participants study paintings done by various artists and either blocked paintings by artist or interleaved artists during the initial study phase. They found that paintings that were interleaved resulted in significantly better test performance when later attempting to identify new paintings done by those artists. This finding has been replicated in other settings as well with different material (for reviews see Brunmair & Richter, 2019; Firth et al., 2021).

The distribution of time between study prior to a final assessment has also been found to markedly impact retention of information. For instance, Kornell (2009) had participants study flashcards with synonym vocabulary pairs (e.g., 'effulgent: brilliant'), either studying all flashcards in each daily session twice (spaced) or studying fewer words many times in one daily

session (massed). Thus, the number of times each word was studied was the same across conditions but varied as to whether the studied word occurred all in one day versus over a few days. Kornell's results indicated that studying all words each day led to better recall on a final test than spending the same amount of time massing a smaller number of words on one day. This finding that spaced study outperforms massed study has been shown repeatedly over the past century (see Cepeda et al., 2006, for a review). In addition to support accruing from laboratory studies, a variety of investigations have shown that these approaches to learning are also highly effective in classroom settings (Barzagar & Ebersbach, 2019; Sana & Yan, 2022; Shobe, 2022). However, do students use effective strategies in their own learning?

Student Utilization of Effective Study Strategies

Kornell and Bjork (2007) surveyed 472 undergraduate students about their study strategies and found that students often triage when deciding when and what to study, focusing on what is due soonest/overdue and topics that are the most challenging. Only 11% of surveyed students indicated that they planned out and spaced their study. Hartwig and Dunlosky (2012) sought to replicate Kornell and Bjork (2007) and build upon their survey by asking what strategies students used regularly. In addition to indicating that they studied whatever was due soonest, most students (54%) still reported that they tested themselves as a knowledge check rather than as a way of learning, similar to findings reported by Kornell and Bjork's (2007; 68%). The most regularly used strategies were underlining/highlighting text (72%), testing oneself (71%), rereading (66%), and cramming before a test (66%). Such data are consistent with several other surveys (e.g., Geller et al., 2018; Morehead et al., 2016; Susser & McCabe, 2013; Wissman & Rawson, 2016), indicating that students do not consistently use the strategies most beneficial for learning. Indeed, Miyatsu et al. (2018) reported a summary of previous surveys of students

and their use of various study strategies. Five popular strategies supported by students were rereading (78%), flashcards (55%), highlighting (53%), note-taking (30%), and outlining (23%). Miyatsu et al. noted that some strategies could become effective with adjustments to make them more beneficial for learning. Rivers (2021) evaluated 16 previous studies gauging students' use of study strategies and found that most students reported rereading (62%), completing practice problems/discussion questions (61%), self-testing (57%), and repetition/memorization (48%), suggesting a mix of empirically supported strategies and less beneficial strategies.

Blasiman et al. (2017) reported that students' intentions may not always match their actual study behavior. They surveyed 268 undergraduate students from 11 different introductory and intermediate courses regarding how they intended to study for courses and followed up multiple times in the semester to ask students what strategies they utilized. Students had intended to read and copy notes, use flashcards, and engage in practice tests but later reported that they read their notes and often reread text as well. The majority reported that they did not utilize more effective strategies (e.g., practice testing) as they intended. Importantly, students had also planned to study more in the week leading up to the exam (i.e., engage in spaced study) but, in their actual study practices, reported studying less overall and focusing on the day or two before the exam (see Bosch et al., 2021, for a similar finding). This disconnect between intention and reality provides more insight into where improvements can be made.

Although prior studies have asked students to self-report their study strategies, McCabe (2011) explicitly asked students to rate the value of different study strategies. Specifically, McCabe (2011) presented undergraduate students with learning scenarios asking them to rate the value of a strategy. For example:

“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 2 weeks, all students are asked to list the cranial nerves in order.”

Students then rated the two assignments on a 7-point Likert scale indicating a “1” as Assignment A would be most valuable to learning and a “7” as Assignment B being most valuable. This survey found that most students did not endorse the better learning strategy, indicating that awareness of beneficial strategies is low (see also Morehead et al., 2016).

Many of the discussed studies and surveys have been conducted in populations of students in psychology courses, as that pool of students is most often available to researchers and represent a cross-section of majors on campus (i.e., many are not psychology majors). Cervin-Ellqvist et al. (2021) surveyed 416 engineering students in various engineering courses to identify the strategies they used for study and their perceived level of effectiveness. The students reported that they most often studied old exams (83%), read course materials/notes (63%), completed practice problems (47%), and summarized (31%). Students also rated the strategies in effectiveness and showed accurate awareness of strategies and their levels of benefit when compared with strategies identified by researchers as having the highest utility (Dunlosky et al., 2013).

Beyond Undergraduate Students

Empirically supported study strategies have been primarily investigated among undergraduates but, in the past decade, researchers have examined knowledge in other populations. Yan et al. (2014) surveyed participants via MTurk, a web-based research platform,

to recruit participants of various ages and education levels. Like undergraduate students, these participants indicated that they would study in a triage mindset (what is due soonest--61%--and what they are doing the worst in--20%) while not spacing study. Participants also identified testing as a knowledge check (62%) rather than a form of learning (15%). Hagemeyer and Mason (2011) surveyed students in a pharmacy school regarding their perceptions and use of various study strategies. Pharmacy students indicated that tests and exams were meant to serve as an assessment of learning but 65% agreed that those tests increased the amount of information they learned and indicated that they wanted to be tested more frequently. Most pharmacy students reported that they crammed for exams and studied what was due soonest rather than planning. Although 88% agreed that spacing study is best for memory, most rarely reviewed past course material. Only 12% of pharmacy students indicated they studied the way they did because instructors had taught them.

In another professional school setting, McAndrew et al. (2015) asked second-year dental school students to rank their top 5 most used study strategies and how they would study a textbook chapter after reading it for the first time. The top strategies endorsed by dental students were re-reading notes/text, memorizing, highlighting, re-writing notes, followed by practicing recall. When reading a textbook chapter, 46% of dental students indicated that they would try to recall as much as they could rather than re-read or use a different strategy. These results suggested that the dental students were not utilizing the most effective study strategies and may not be aware of the powerful benefits of certain strategies. Piza et al. (2019), surveying medical and dental students, reported similar results as previous undergraduate surveys. Professional students used some effective study strategies, such as testing themselves (73%), but also

frequently used strategies found to be less beneficial for long term learning like rereading (48%), highlighting (58%), and cramming (43%).

Several surveys have asked about learning styles, the idea that a particular mode of learning information (e.g., visual or auditory learner) is best for an individual. There has been little to no evidence supporting that teaching to match a learning style is beneficial (Pashler et al., 2008; Willingham et al., 2015). Over half of the surveyed medical and dental students (McAndrew et al., 2015; Piza et al., 2019) believed that they had a specific learning style, with one study of university faculty (Morehead et al., 2016) indicating an even greater level of endorsement (91%). Most professional students reported the strategies they used did not come from an instructor but 52% of the faculty surveyed indicated that they discussed techniques in their class.

Study Strategy Interventions

Although effective study strategies are well documented, a disconnect remains for sharing and implementing these strategies. Some researchers (e.g., Miyatsu et al., 2018) have provided specific recommendations for psychologists and instructors, as well as students for implementing effective study strategies. However, typical students are unlikely to read a journal article when seeking guidance on how to study. Many students (78%), particularly younger students, report opting to study in groups when covering material for a class (McCabe & Lummis, 2018). McCabe and Lummis further found that when surveyed about their group study experiences, students were likely to engage in mostly effective study strategies such as spacing, testing flashcards, quizzing each other, and teaching one another. The students reported encouragement from their professors and peers to participate in these groups and 67% reported feeling more motivated by working in groups. Group study that already occurs may be a good

setting to inform and implement empirically supported study strategies, but the benefits of informing and instruction of these strategies need to be examined.

McCabe (2011) investigated various interventions, such as targeted instruction to introductory psychology students and in-depth discussion with advanced seminar cognition students, to evaluate change in awareness and endorsement. The impact of the interventions was measured with the previously described learning scenarios. However, only students in the seminar group, where topics were heavily discussed and research articles were read, did a preponderance of students (71%) endorse effective study strategies. Even with substantial intervention in the seminar group, a sizable minority of participants (29%) did not endorse empirically supported study strategies.

In addition to assessing knowledge of beneficial strategies, several studies have examined whether students make use of beneficial learning strategies after becoming aware of them. For example, Kirk-Johnson et al. (2019) exposed participants to various study strategies and asked participants to rate their perceived effectiveness and the mental effort that was experienced. The results indicated that the higher the effort that was reported for a strategy, the lower the perceived effectiveness of learning. In addition, participants were less likely to use a strategy if the effort was high and perceived effectiveness was low, suggesting that the level of effort involved predicts choice in future study periods (cf. Bjork, 1994). Hui et al. (2022) similarly reported, among participants learning anatomy, that higher ratings of mental effort were associated with a reduced choice of retrieval practice relative to restudying. As this study was conducted over the span of many days, participants were also given individual feedback on their performance and allowed to decide on how to study moving forward. After feedback on their performance,

participants were more likely to choose retrieval practice over restudy suggesting that providing feedback may influence choice of study strategy.

A transition into use of course materials was made by Broeren et al. (2023) whereby students were either provided with retrieval practice on course concepts or retrieval practice of those concepts with strategy instructions and metacognitive support over email. Instructions and support were sent as email tips on self-testing or why it is beneficial, as well as helping them monitor their progress and provide specific feedback. The retrieval practice with emails group utilized retrieval practice more and had more successful retrieval attempts when compared to a control group with no emails or retrieval practice but, not significantly better than the group with retrieval practice alone, suggesting that this is a step towards implementation.

Biwer et al. (2023) implemented a learning strategy training program for 126 first-year pharmacology students whereby all students participated once a week for 90 minutes for the first few weeks. After the first midterm, the 20% lowest scoring students were to take part in the program for the remainder of the semester to plan and implement strategies to improve performance. The program first would first raise awareness of effective study strategies by challenging prior beliefs and informing students of empirically supported strategies followed by sharing experiences and practicing the strategies together in the program. This was followed by reflection on motivations and perceived difficulties of the strategies. Results showed that the program improved metacognitive knowledge and increased the use of effective study strategies compared to a control class the year before. The difference in the student rankings shrank and Biwer et al. reported no significant difference in final exam test scores among low, middle, and top-ranking students while the previous year students had remained in their various performing

ranks. This implementation shows great promise of how a course can provide improved awareness and academic outcomes, but the question arises: Who oversees the implementation?

Instructors' Role in Guiding Study

Instructors are often the default source for informing students on how to study. For instance, Krueger et al. (2023) asked students who should be responsible for providing practice testing opportunities for learning. The majority (61%) of students identified the instructor as responsible for implementing this as instructors are the “experts”. Wissman et al. (2012) similarly found that 76% of students reported that an instructor had taught them how to study. The most common study strategy students had learned from instructors was to reread material. Wissman et al. identified this as an area of opportunity for increasing instructors' awareness of effective and empirically supported study strategies.

Morehead et al. (2016) combined the student study habit survey questions from Kornell and Bjork (2007) and Hartwig and Dunlosky (2012) with the learning strategy scenarios from McCabe (2011). Different from the original studies, Morehead et al. asked the study habit questions and the scenarios to both students and instructors, with the study habit questions modified when given to instructors. For instance, whereas the students' question would be “If you quiz yourself while you study, why do you do so?”, the instructors' questions would be “If you think students should quiz themselves, why should they do so?”. Results comported with previous research, suggesting that most students triage their study (72% reported studying what's due soonest or doing the worst in), reread material (67%), and cram in one session before a test (52%). In the learning scenarios taken from McCabe (2011), Morehead et al. found that in a scenario comparing spaced study versus cramming, students were more likely to support the empirically supported spaced study; otherwise, non-empirically supported options like high

interest details, animated media, and blocking material were rated much higher than their empirically supported option. Students also rated the empirically supported and non-empirically supported options for generation and testing similarly, suggesting that students may have thought both options were comparable in benefit. The findings suggest that students have a moderate level of knowledge regarding study strategies.

When surveying instructors, Morehead et al. (2016) found that 79% of instructors reported discussing study strategies in their class and most reported encouraging beneficial strategies such as spacing study (61%), asking questions (62%), and self-testing (65%). Other strategies endorsed by instructors were found to be less effective, such as re-reading (41%), underlining/highlighting (42%), and believing that learning reflected learning styles (91%). Regarding the learning scenario ratings, more instructors than students were accurate in supporting the value of generating information, with a medium effect size of $d = 0.58$. Instructors also more frequently supported testing over rereading when compared to students, with a small effect of $d = 0.30$. With the other learning scenarios, instructors rated the scenario's level of benefit very similarly to the students. The findings from Morehead et al. suggest that instructors endorse similar study strategies as students and showed a small advantage in knowledge of beneficial learning strategies.

Hunter and Lloyd (2018) surveyed non-psychology undergraduate faculty about how they instructed their students to study for exams regarding a particular course. The survey presented open-ended questions, allowing faculty to share the information they would pass along to students. Most of the faculty reported discussing study skills with the students (91%) but, of them, less than half listed at least one empirically supported strategy such as spacing or retrieval practice; the remainder identified strategies such as reviewing material or rereading. Faculty

endorsing empirically supported strategies were more likely to be experienced in teaching a course 10 or more times (43%). Hunter and Lloyd drew similarities to Morehead et al. (2016) in that most faculty are not primarily encouraging those empirically supported strategies, allowing room for improvement in sharing strategies to students.

Surma et al. (2022) surveyed novice teachers with less than 2 years of experience in secondary education and found that when asked what study strategies they would recommend to their students, less beneficial strategies such as summarizing and highlighting were identified alongside more beneficial strategies like practice testing and self-explaining. When given a list of strategies to rate effectiveness, novice teachers were more likely to support empirically supported strategies. The studies of instructors' knowledge and endorsement of strategies are essential as researchers must first understand the level of knowledge to provide appropriate levels of support.

Few studies have examined instructors' knowledge of study strategies and a large gap in that knowledge remains in professional schools. Piza et al. (2019) is one of the few studies on professional programs that included a survey like Morehead et al. (2016) of both students and faculty in a handful of medical and dental schools. While there was overall a very similar pattern to Morehead et al. (2016) in faculty responses, fewer reported discussing study techniques in class.

Suda et al. (2011) surveyed pharmacy school faculty perceptions of effective study strategies by conducting focus groups. While most of the time allocated during these focus groups examined technology use and the material used in class, general responses from faculty suggested that spacing study over weeks and in-classes quizzes were regarded as beneficial. The study's focus groups were only on one pharmacy school without quantitative measures but still provided insight of a scarce gap in professional school instructors.

Hagemeier and Mason (2011) emphasized the magnitude and growth of information that pharmacy students are exposed to during school and beyond. It could be argued that veterinary medicine holds an even wider breadth of information to cover regarding various species of animals while still understanding and treating each system as other medical professionals (American Veterinary Medical Association, n.d.). Veterinarians are also lifelong learners with constant exposure to new research for treatments and care for animals. The number of faculty at U.S. colleges of veterinary medicine has risen 30% over the past decade (2013-2023) to keep up with the growing enrollment of veterinary students (American Association of Veterinary Medical Colleges, 2023). In a survey sent to faculty employed at Association of American Veterinary Medical Colleges (AAVMC) member colleges, 78% of respondents indicated moderate or high level of interest in professional development for teaching (Lloyd et al., 2020). These reports emphasize the growing number of new faculty and the high interest in optimizing instructor performance. Veterinary instructors seem to be missing from the literature in evaluating their knowledge and use of study strategies. The next step in instructor growth is to assess veterinary instructor knowledge and endorsement of learning strategies. In the current study, I assessed instructors in veterinary schools by gauging their knowledge and use of empirically supported study strategies and identified impediments to learning.

Current Study

The current study consisted of a survey sent out to all identifiable veterinary school instructors in the United States. I determined the level of knowledge and teaching of empirically supported study strategies of instructors in veterinary schools by providing a survey adapted from Morehead et al. (2016), with scenarios and questions tailored to veterinary medicine. The questions included beliefs and use of study strategies as well as learning scenarios to establish

support or opposition of empirically supported study strategies. The current study included an evaluation of how knowledge of study strategies correlates with the acceptance rate and national ranking of the veterinary school by the U.S. News and World Report (2023). To my knowledge, this was the first attempt to link knowledge of study strategies to an institution's academic reputation. Veterinary schools are ranked by peer surveys sent to deans, administrators, and faculty of accredited veterinary schools measuring academic quality of students, research, and faculty.

I hypothesized that, like previous studies of undergraduate and professional instructors, there would be support for both empirically supported (self-testing and spaced study) and non-empirically supported strategies such as highlighting, rereading, and accommodating to learning styles. I also hypothesized that the ranking of the school would correlate with more endorsement of empirically supported study strategies, as higher-ranking schools would have more resources to support and educate instructors in teaching and learning. In the learning scenarios, I hypothesized that most instructors would support generation, spacing, and testing effects while few would support low interest details, static media, and interleaving materials, similar to findings from Morehead et al. (2016).

METHODS

Participants

Participants were recruited in the spring of 2024 based on publicly shared online information that indicated the individual's position as an instructor, intern/resident, faculty member, and/or professor at a college of veterinary medicine. All 33 accredited veterinary schools in the United States were contacted in this study. Email correspondence was used to recruit as well as disclose information about the study to the participants. In total, 5,238 email addresses were identified and 430 instructors responded to the survey (430/5,238, 8%). Of those 430 responding, 8 responded "No" to currently or previously teaching veterinary students and 67 completed less than 75% of the survey, leaving usable data from 355 participants (355/5,238, 7%). Participants (117 men, 234 women, 1 non-binary/third gender, 3 not reporting) were between 26 and 75 ($M = 46.35$, $SD = 11.39$) years old with 19 not providing age. Of the 354 participants reporting racial or ethnic group, most identified as White (313, 88%), followed by Hispanic or Latino (20, 6%), Asian (12, 3%), and less than 2% identifying as American Indian or Alaska Native (5), Black/African American (5), or Other (4) with 7 not providing.

Materials

Instructor Surveys and Learning Scenarios

Survey questions administered to participants were adapted from previous survey items (Morehead et al., 2016; Beseler et al., 2022). Some questions were adjusted to include information tailored to veterinary professionals. These adjustments included altering the wording of one learning scenario from paintings with art history professors to gross changes with pathology professors as well as including the NAVLE, the licensing exam for veterinarians, as an

option for choice in testing format. All information presented was on the Qualtrics platform. Participants initially answered general demographic questions related to their experience and role. The study strategy questions consisted of 16 multiple choice questions related to their beliefs and use of study strategies with veterinary students. The final portion of the survey consisted of 6 learning strategy scenarios that asked participants to rank how helpful each strategy in the scenario was on a scale of 1 – 7 (1 being *not beneficial* and 7 being the *most beneficial*). There was a final comments section available for participants to note any additional comments, best methods of study, how students should and do study, and why. The Appendix contains all survey questions that were included.

Procedure

Participants were informed that the survey was intended to better understand the instructors' role in veterinary student study techniques. Within the email sent to participants, the link to the instructor survey was provided to complete at their convenience and included demographic information, study strategy questions, and learning scenarios. The order of study strategy questions and learning scenarios was randomized to control for potential carryover from one to the other. There were 174 instructors who completed the study strategy survey questions first and 181 instructors that completed the learning scenarios first. The survey was closed 3 weeks after the initial e-mail was sent to participants.

Scoring and Analysis

Learning scenario ratings were scored as empirically supported or non-empirically supported, following guidelines from McCabe (2011) and Morehead et al. (2016). Regarding the question of what learning techniques the instructors recommended, the total number of strategies,

the number of beneficial study strategies, and the number of non-beneficial study strategies were calculated based on guidelines from Holm et al. (2022).

Correlations involving acceptance rate and the rank of the veterinary program were calculated by assigning the rank provided by the 2023 post of Best Veterinary Schools (U.S. News and World Report, 2023) and calculating the acceptance rate by dividing the class size by total applicants for the Fall 2022 provided by the American Association of Veterinary Medical Colleges (Greenhill, 2023).

Participant Removal

Participants' data were removed if 25% of the survey was incomplete or if the participant indicated that they do not currently or have previously taught veterinary students.

RESULTS

Participant Characteristics

There were 5,238 email addresses identified based on publicly shared online information that indicated an individual's position as an instructor, intern/resident, faculty member, and/or professor at a college of veterinary medicine. Individuals at all 33 accredited veterinary schools in the United States were contacted. Of those contacted, 430 instructors responded to the survey (430/5,238, 8%) and 355 of the instructors answered "Yes" to currently or previously instructing veterinary students and completed 75% or more of the survey (355/5,238, 7%). The instructors predominantly identified as women (66%) and most identified as White (88%). The instructors had a wide range of teaching experience from less than one year to over 45 years, with a mean of 13.94 years of teaching ($SD = 10.78$), with most primarily teaching in a clinical setting (51%). Further details regarding the background of the instructors can be found in Table 1. A summary of free responses to questions identified as 'Other' are provided in Appendix B.

Survey Results

Veterinary instructors' responses to survey questions were consistent with findings with prior surveys in other areas of academia with a few notable differences (Morehead et al., 2016; Piza et al., 2019). Only about half of the instructors (52%; question 1) reported actively discussing learning techniques in class and, of those who did discuss learning, the largest percentage reported discussing this about once every semester (31%, Question 2). The majority of instructors reported providing quizzes to students, but some only provided a quiz every few weeks (12%, Question 5) or a couple times a semester (12%, Question 5). Instructors strongly supported students studying based on a planned study schedule (80%, Question 7), but few

Table 1*Instructor Demographic and Background Information*

<i>Variable</i>	<i>N</i>	<i>Percentage</i>
<i>Gender Identity</i>	(354)	
Male	117	33.05%
Female	234	66.10%
Non-Binary/Third Gender	1	0.28%
Prefer Not to Say	2	0.56%
<i>Racial/Ethnic Group</i>	(354)	
White	313	88.42%
Black/African American	5	1.41%
American Indian or Alaskan Native	5	1.41%
Asian	12	3.39%
Hispanic or Latino	20	5.65%
Other	4	1.13%
Prefer Not to Say	7	1.98%
<i>Number of years teaching</i>	(354)	
0 – 5 years	89	25.14%
6 – 10 years	85	24.01%
11 – 15 years	59	16.67%
16 – 20 years	34	9.60%
21+ years	87	24.58%
<i>Year of vet student taught</i>	(352)	
First Year	216	61.36%
Second Year	235	66.76%
Third Year	244	69.32%
Fourth Year	273	77.56%
<i>Position</i>	(354)	
Assistant Professor	110	31.07%
Associate Professor	92	25.99%
Professor	88	24.86%
Adjunct Instructor	2	0.56%
Clinical Instructor	16	4.52%
Intern/Resident	23	6.50%
Other	23	6.50%
<i>Primary Teaching Environment</i>	(355)	
Classroom	92	25.92%
Online	5	1.41%
Laboratory	26	7.32%
Clinical	182	51.27%
Field	10	2.82%
Hybrid	40	11.27%
<i>Received Teacher Education Training</i>	(355)	
Yes	252	70.99%
No	103	29.01%
<i>Interest in learning more teaching/instruction strategies</i>	(354)	
Definitely Not	3	0.85%
Probably Not	19	5.37%
Might or might not	49	13.84%
Probably yes	116	32.77%
Definitely yes	167	47.17%

believed that students engaged in that practice (5%; Question 6). Similar to previously surveyed instructors, most instructors thought that students chose to study whatever is due soonest or overdue (84%; Question 6).

Most veterinary instructors noted that they recommended learning techniques to students either in class or in out of class meetings (70%, Question 9). Of the instructors who recommended learning techniques, many of those techniques are empirically supported, including self-testing (80%, Question 10), using flashcards (38%, Question 10), making outlines (48%, Question 10), and making diagrams, charts, or pictures (62%, Question 10). The veterinary instructors also reported returning to earlier material in later sections (71%, Question 8) but, interestingly, slightly less than half reported using or encouraging spacing techniques in class (49%, Question 13). Overall, instructors supported more beneficial strategies ($M = 2.28$, $SD = 1.17$) than less beneficial strategies ($M = 0.80$, $SD = 0.91$), $t(244) = 17.45$, $p < 0.001$, $d = 1.41$, such as recopying notes (23%, Question 10), rereading (30%, Question 10), underlining or highlighting (26%, Question 10), or cramming before a test (0%, Question 10). There was no relationship between the number of years an instructor had been teaching and the number of beneficial strategies endorsed, $r(242) = -0.10$, $p = 0.11$.

Of the strategies that instructors recommended to students, 74% of instructors thought that some students do and some do not use those techniques when provided (Question 11). Veterinary instructors were also very likely to support the idea that students have different learning styles (87%, Question 14) and the vast majority of those who endorsed learning styles reported teaching to accommodate those learning style differences (88%, Question 15).

When asked about the type of advice a veterinary instructor would provide to a struggling student, most instructors would offer suggestions for how to study more effectively (95%, Table

3). The instructors reported being much more unlikely to provide advice of dropping the class (72%), assigning less homework (73%), or explaining that not everyone is meant to pursue that career (65%).

Veterinary instructor support of beneficial and non-beneficial learning strategies identified was also evaluated in regard to the correlation with the rank and acceptance rate of the veterinary school affiliation. To better describe the relationship of rank within correlations, the rank order of the veterinary school was reversed so as the school ranked 1 becomes 33 and 2 becomes 32 and so on. This reverse-ordering allows the larger number rank to become the “higher ranking” school. The rank as well as the acceptance rate of the reported veterinary school showed no relationship with the number of beneficial learning strategies endorsed ($\rho = 0.013, p = 0.84$ and $\rho = 0.009, p = 0.89$)¹. Program rank was negatively correlated with the number of non-beneficial strategies, such that individuals responding from programs with lesser rankings were more likely to endorse non-beneficial strategies ($\rho = -0.23, p < 0.001$)², while the acceptance rate and the number of non-beneficial strategies endorsed were weakly related ($\rho = 0.05, p = 0.41$). The relationship of using or encouraging spacing techniques and the increase in acceptance rate of a university was likewise weakly correlated ($\rho = -0.09, p = 0.82$).

Influence of Order

The order of study strategy questions and learning scenarios was randomized to control for potential carryover from one to the other. The results showed that the group answering the learning scenario questions first reported more strategies, $t(240.49) = 2.64, p < 0.01, d = 0.34$, and more beneficial strategies from that list, $t(242.95) = -3.32, p = 0.001, d = -0.42$. There were

¹ Goodman and Kruskal's gamma was proposed to calculate the correlation but as the data are true rank data, Spearman's correlation was found to be more appropriate.

² $G = 0.23, p < 0.01$

also differences in the groups to report the reason why students should quiz themselves. The group that saw the learning scenarios first were more likely to indicate that students should quiz themselves because they will learn more that way whereas the group that saw the study survey first were more likely to identify students should quiz themselves to determine how well they have learned the information $\chi^2(2, N = 347) = 6.50, p < 0.05$, with a small effect size ($V = 0.14$).

Scenario Results

The learning scenario questions were answered on a scale of 1-7 from *least beneficial to learning* to *most beneficial to learning* with a score of 4 serving as a neutral evaluation. Table 4 shows the mean ratings for the empirically supported (ES) options and the non-empirically supported (non-ES) options. The ES and the non-ES options were then statistically compared to one another using a paired samples t-test, with effect sizes for differences reported via *Cohen's d*. Instructors largely supported the ES options of generation and spacing when compared to the non-ES options (*Cohen's d* = 0.99 and 1.86, respectively). They also moderately favored testing over restudying ($d = 0.41$). Regarding the non-ES options of high interest details, animated media, and massing study, there was very large support for those non-ES options when compared to the ES options (d s ranging from -1.01 to -1.46). This pattern of support for generation, testing, and spacing and lack of support for low interest details, static media, and interleaving is consistent with previous literature (Morehead et al., 2016). Table 5 shows the percentage of instructors who provided a greater rating to the ES option as opposed to the non-ES option. I discuss these and other findings in the General Discussion.

Table 2*Instructor Responses to Study Strategy Survey*

	<i>Question</i>	<i>Choices</i>	<i>Percentage</i>	<i>Frequency</i>
1	Do you discuss study techniques in class?	Yes No	52% 48%	186/355 169/355
2	If yes, how often do you discuss learning techniques?	A few times a week About once a week Before tests/major assignments About once every semester Other	10% 22% 24% 31% 13%	18/186 41/186 44/186 58/186 25/186
3	What testing format do you use most often?	Essay/short answer exams Multiple-choice exams About the same Other	8% 56% 11% 24%	29/353 199/353 39/353 86/353
4	Why do you use this testing format?	Ease, simplicity of grading Ease, simplicity of item construction Captures key constructs from class Encourages better student learning To match the NAVLE format Other	59% 21% 32% 23% 23% 30%	207/349 75/349 112/349 81/349 80/349 104/349
5	How often do you provide quizzes to your students?	A few times a week About once a week Every few weeks A couple times a semester I don't provide quizzes Other	10% 22% 12% 12% 31% 12%	35/354 79/354 44/354 43/354 111/354 42/354
6	How do you think your students choose to study?	Whatever is dues soonest/overdue Whatever they haven't studied for the longest time Whatever they find interesting Whatever they feel they're doing the worst in Based on a planned study schedule	84% 1% 5% 5% 5%	296/353 3/353 19/353 18/353 17/353
7	How do you think your students should choose to study?	Whatever is dues soonest/overdue Whatever they haven't studied for the longest time Whatever they find interesting Whatever they feel they're doing the worst in Based on a planned study schedule	4% 1% 3% 12% 80%	14/352 3/352 10/352 43/352 282/352

	<i>Question</i>	<i>Choices</i>	<i>Percentage</i>	<i>Frequency</i>
8	Do you return to earlier material in later sections? (e.g., reviewing week 1 material near the middle of the semester)	Yes No	71% 29%	250/353 103/353
9	Do you recommend learning techniques to students, either in class or during out of class meetings?	Yes No	70% 30%	246/352 106/352
10	If yes, which of the following learning techniques do you recommend students use regularly? (please check all that apply)	Test yourself with questions or practice problems Use flashcards Recopy your notes Reread chapters, articles, notes, etc. Make outlines Underline or highlight while reading Make diagrams, charts or pictures Study with friends 'cram' lots of information the night before the test Ask questions or verbally participate during class Other	80% 38% 23% 30% 48% 26% 62% 63% 0% 73% 26%	195/245 93/245 57/245 74/245 118/245 63/245 152/245 155/245 1/245 180/245 63/245
11	If yes, do you think students use those learning techniques?	Yes Yes, for my class but not necessarily for others No Some do, some do not	17% 8% 1% 74%	41/246 20/246 3/246 182/246
12	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 To figure out how well they have learned the information they're studying I do not think quizzing will necessarily benefit students	24% 69% 7%	84/347 239/347 24/347
13	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 No	49% 51%	169/346 177/346
14	Do you believe students have different learning styles (e.g., visual vs. auditory learners)?	Yes No	87% 13%	307/353 46/353
15	If yes, do you teach to accommodate those learning style differences?	Yes No	88% 12%	269/306 37/306

Table 3*Likelihood of Instructor Advice to a Struggling Student*

Instructor Advice	Extremely Unlikely	Somewhat Unlikely	Neither Likely nor Unlikely	Somewhat Likely	Extremely Likely
Explain that not everyone has "physiology talent" - some people are better able to understand intangible concepts and some people are not	62% (217/348)	15% (52/348)	11% (39/348)	8% (29/348)	3% (11/348)
Console the student for the grade by telling them plenty of people have trouble in physiology but go on to be very successful in other fields	30% (105/349)	25% (86/349)	15% (51/349)	24% (84/349)	7% (23/349)
Explain that not everyone is meant to pursue a career in physiology	65% (227/349)	14% (49/349)	12% (43/349)	6% (21/349)	3% (9/349)
Assign less physiology homework	73% (254/349)	18% (64/349)	7% (25/349)	1% (2/349)	1% (4/349)
Talk to the student about dropping the class	72% (250/348)	17% (59/348)	9% (32/348)	1% (4/348)	1% (3/348)
Offer suggestions for how to study more effectively	1% (3/349)	0% (1/349)	4% (14/349)	24% (82/349)	71% (249/349)

Table 4*Instructor Ratings for the ES Option and Non-ES Option in the Learning Scenario Questions*

<i>Scenario</i>	<i>ES option</i>		<i>Non-ES option</i>		<i>Comparison</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>Cohen's d</i>
Generation	5.85	1.21	4.71	1.19	13.22*	0.99
Low interest details	3.36	1.37	5.33	1.39	17.24*	-1.46
Static media	4.25	1.11	5.69	1.08	17.10*	-1.32
Testing	4.63	1.62	3.98	1.52	4.63*	0.41
Interleaving	3.79	1.44	5.21	1.40	10.62*	-1.01
Spacing	5.93	1.06	3.75	1.26	22.83*	1.86

ES – Empirically supported learning strategy

* $p < 0.001$

Table 5

Percentage of Instructors Favoring the ES Option over the Non-ES Option

<i>Scenario</i>	<i>Percentage</i>
Generation	73.56%
Low interest details	9.88%
Static media	5.07%
Testing	55.59%
Interleaving	23.01%
Spacing	80.00%

ES – Empirically supported learning strategy

GENERAL DISCUSSION

The current study sought to examine what veterinary medicine instructors believe regarding how veterinary students should best study and learn information. This work adds to previous research by filling a gap in instructor surveys in the professional school setting and, more specifically, in veterinary medicine education. Instructors in undergraduate settings and in several other academic areas have been surveyed, indicating that instructors suggest a mix of both beneficial and non-beneficial learning strategies, while identifying areas of potential growth (Morehead et al., 2016; Piza et al., 2019; Hunter & Lloyd, 2018). The results of this study provide insight regarding veterinary school instructors' knowledge and endorsement of empirically supported study strategies.

Key Results: Survey

As hypothesized, in the survey questions, instructors endorsed both empirically supported study strategies such as self-testing (80%), making diagrams, charts, or pictures of information (62%), and spacing study with a planned study schedule (80%). However, to a lesser degree, they also supported less beneficial strategies such as highlighting (23%) and rereading (30%). There was also substantial support for learning styles (87%), despite the entire dearth of evidence for matching instruction to learning style (Pashler et al., 2008; Willingham et al., 2015). With just over half (52%) of the instructors reporting that they actively discussed learning techniques in class, most either reported discussing these techniques about once a semester (31%) or only before major tests or assignments (24%). This is an area where large improvements could be made. For instance, if instructors more frequently discussed learning techniques but also were informed and could strategically endorse more empirically supported strategies and fewer non-

beneficial strategies, the effectiveness of student learning could change. Of note, the number of empirically supported strategies endorsed was largely unrelated to the rank of the veterinary school or the acceptance rate. The only correlation found was that lower ranking schools were positively correlated with an increased number of non-beneficial strategies chosen. Interestingly, the number of years an instructor had reported teaching did not correlate to more beneficial strategies as was found in Hunter and Lloyd (2018).

Instructors also reported choosing multiple-choice exams as the format most frequently used (56%) for their ease and simplicity of grading (59%). As testing oneself and being tested serves as a learning opportunity (Yang et al., 2021), the question of how frequently instructors quiz their students was included. Nearly one third of the instructors noted that they do not provide quizzes at all (31%) and another 32% reported quizzing their students at least once a week. With the various environments that these instructors teach in (51% in clinical setting; 26% in classroom), regularly providing a written, verbal, or electronic quiz could be an opportunity for additional student learning (Yang et al., 2021). Although quizzing provides information regarding how well one has learned information, few instructors indicated that students will learn more by quizzing than by rereading (24%). With the overwhelming amount of material instructors and students know they must learn, instructors indicated that students likely prioritize their study with what is due soonest/overdue (84%), but instructors reported that a spaced and planned study schedule would be the best way to study (80%). Whether the design of instruction permits or encourages such spacing is unknown. When meeting with a struggling student, 95% of veterinary instructors were somewhat or extremely likely to offer suggestions for how to study more effectively.

Key Results: Learning Scenario Comparisons

In the learning scenario questions, over half of the instructors gave higher ratings to empirically supported options such as spacing (80%), testing (56%), and generating examples (74%) as opposed to their non-empirically supported option. These empirically supported strategies were also supported in other survey questions like suggesting to students to test oneself (80%, Question 10), encouraging a planned study schedule (80%, Question 7), and generating diagrams, charts, or pictures (62%, Question 10). Instructors also did not support the empirically supported options of interleaving study (23%), including low interest irrelevant details (10%), and static images (5%) when compared to their non-empirically supported option. These results mimic findings from other instructor surveys (Morehead et al., 2016) and suggest that the surveyed instructors may be unaware of the impact limited cognitive resources has on information that needs to be learned (Paas et al., 2003) or that interleaving material rather than blocking by topic is beneficial (Firth et al., 2021).

Implications and Caveats

Although 71% of the instructors responding to this survey indicated that they had received teacher education training ranging from seminars to courses taken to completion of advanced degree in veterinary education, 80% indicated an interest in learning more about teaching and instructional strategies. This comports with a previous survey by the AAVMC, whereby 78% of respondents reported an interest in professional development of teaching (Lloyd et al., 2020). With the number of veterinary school instructors increasing by 30% in the past decade to accommodate the growing demand of veterinarians in the United States, the current study suggests there is also a desire to teach veterinary students implementing best practices for supporting learning.

The results provided are valuable in contributing to further understanding of professional school instructors that can help guide future life-long learners in professional fields like veterinary medicine. As with any single survey of self-reported strategies, what has been reported may not be what instructors actually endorse to students or reflect practice. The current survey included an open comments section at the end asking for comments on learning techniques, what their views are, and what students do, allowing instructors to provide additional insights on their views of learning and teaching. Nearly half noted their support of one or more empirically supported learning strategies (44%), while many noted the large amount of material and lack of time in veterinary programs (20%) and how students struggle with the material (24%). The lack of further observational methods into what is done in the classroom and how students decide to study is a limitation but serves as a first step into understanding instructors in veterinary medicine. Surveys were sent to all publicly identified instructors of accredited veterinary students in the United States, but self-selection bias could have allowed for instructors that may be more confident or knowledgeable in study strategies to complete the survey over instructors that have less confidence or interest in study methods. Nonresponse may also be indicative of lack of interest in completing surveys, unable to dedicate time to complete, or simply oversaturation of emails regarding more important tasks.

Conclusion

The findings of this survey serve as an assessment of instructors in veterinary schools by gauging knowledge and use of empirically supported study strategies and to identify impediments to learning. The results generally support what has been found with instructors in undergraduate settings (Morehead et al., 2016). The information gained from this study helps identify where veterinary medicine instructors are currently and work moving forward can

support them with the correct knowledge to address their students. Additional investments in widespread empirically supported learning resources are needed to improve academic quality of students and faculty. Although there seems to be many seminars that instructors reported attending (71%), these seminars may be the next logical place to look at when evaluating what is being taught to veterinary school instructors and if the content is empirically based for best teaching and learning. Such sources may be contributing to certain beliefs related to student learning. Veterinary school instructors know of some beneficial learning strategies to use in their classes and what to suggest to students but also continue to suggest and support strategies that are not empirically supported. The current study marks the initial research into this professional school domain and suggests that veterinary school instructors have opportunities to reexamine learning strategies they use with and promote for veterinary students.

REFERENCES

- Abbott, E. E. (1909). On the analysis of the factor of recall in the learning process. *Psychological Monographs*, 11(1), 159–177. <https://doi.org/10.1037/h0093018>
- American Association of Veterinary Medical Colleges. (2023). *Annual data report 2022–2023*. <https://www.aavmc.org/wp-content/uploads/2023/09/2023-AAVMC-Annual-Data-Report-September23.pdf>
- American Veterinary Medical Association. (n.d.). *Veterinary training*. Retrieved November 8, 2023, from <https://www.avma.org/resources/pet-owners/yourvet/veterinary-training>
- Barzagar Nazari, K., & Ebersbach, M. (2019). Distributing mathematical practice of third and seventh graders: Applicability of the spacing effect in the classroom. *Applied Cognitive Psychology*, 33(2), 288–298. <https://doi.org/10.1002/acp.3485>
- Beseler, C. L., Hausman, H., Pilgrim, M. E., Rhodes, M. G., & Chavez, E. (2022). Community college instructors' perceptions of success in mathematics. *MathAMATYC Educator*, 14(1), 26–32.
- Best Veterinary Schools*. U.S. News & World Report. (2023), from <https://www.usnews.com/best-graduate-schools/top-health-schools/veterinarian-rankings>
- Biwer, F., de Bruin, A., & Persky, A. (2023). Study smart – impact of a learning strategy training on students' study behavior and academic performance. *Advances in Health Sciences Education*, 28(1), 147–167. <https://doi.org/10.1007/s10459-022-10149-z>
- Bjork, R.A. (1994). Memory and metamemory considerations in the training of human beings. In J. Metcalfe & A. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp.185–205). Cambridge, MA: MITPress.

- Blasiman, R. N., Dunlosky, J., & Rawson, K. A. (2017). The what, how much, and when of study strategies: Comparing intended versus actual study behaviour. *Memory*, 25(6), 784–792. <https://doi.org/10.1080/09658211.2016.1221974>
- Bosch, E., Seifried, E., & Spinath, B. (2021). What successful students do: Evidence-based learning activities matter for students' performance in higher education beyond prior knowledge, motivation, and prior achievement. *Learning and Individual Differences*, 91, 1–12. <https://doi.org/10.1016/j.lindif.2021.102056>
- Broeren, M., Verkoeijen, P., Heijltjes, A., Arends, L., & Smeets, G. (2023). Promoting retrieval practice use during self-study in higher education: The effects of a compact strategy intervention with metacognitive support. *Applied Cognitive Psychology*, 37(4), 830–844. <https://doi.org/10.1002/acp.4078>
- Brunmair, M., & Richter, T. (2019). Similarity matters: A meta-analysis of interleaved learning and its moderators. *Psychological bulletin*, 145(11), 1029-1052. <https://doi.org/10.1037/bul0000209>
- Cepeda, N., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: a review and quantitative synthesis. *Psychological Bulletin*, 132(3), 354-380. <https://doi.org/10.1037/0033-2909.132.3.354>
- Cervin-Ellqvist, M., Larsson, D., Adawi, T., Stöhr, C., & Negretti, R. (2021). Metacognitive illusion or self-regulated learning? Assessing engineering students' learning strategies against the backdrop of recent advances in cognitive science. *Higher Education*, 82(3), 477–498. <https://doi.org/10.1007/s10734-020-00635-x>
- 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(1), 4-58.
<https://doi.org/10.1177/1529100612453266>
- Firth, J., Rivers, I., & Boyle, J. (2021). A systematic review of interleaving as a concept learning strategy. *Review of Education*, 9(2), 642-684. <https://doi.org/10.1002/rev3.3266>
- Foos, P. W., & Fisher, R. P. (1988). Using tests as learning opportunities. *Journal of Educational Psychology*, 80(2), 179–183. <https://doi.org/10.1037/0022-0663.80.2.179>
- Geller, J., Toftness, A. R., Armstrong, P. I., Carpenter, S. K., Manz, C. L., Coffman, C. R., & Lamm, M. H. (2018). Study strategies and beliefs about learning as a function of academic achievement and achievement goals. *Memory*, 26(5), 683–690.
<https://doi.org/10.1080/09658211.2017.1397175>
- Greenhill, L. (2023, April 11). *Admitted student statistics*. American Association of Veterinary Medical Colleges. <https://www.aavmc.org/becoming-a-veterinarian/what-to-know-before-you-apply/admitted-student-statistics/>
- Hagemeyer, N. E., & Mason, H. L. (2011). Student pharmacists' perceptions of testing and study strategies. *American Journal of Pharmaceutical Education*, 75(2), 1–10.
<https://doi.org/10.5688/ajpe75235>
- Hartwig, M. K., & Dunlosky, J. (2012). Study strategies of college students: Are self-testing and scheduling related to achievement? *Psychonomic Bulletin and Review*, 19(1), 126–134.
<https://doi.org/10.3758/s13423-011-0181-y>
- Holm, A. J., Hausman, H., & Rhodes, M. G. (2022). Study strategies and “study drugs”: investigating the relationship between college students' study behaviors and prescription stimulant misuse. *Journal of American College Health*, 70(4), 1094–1103.
<https://doi.org/10.1080/07448481.2020.1785472>

- Hui, L., de Bruin, A. B. H., Donkers, J., & van Merriënboer, J. J. G. (2022). Why students do (or do not) choose retrieval practice: Their perceptions of mental effort during task performance matter. *Applied Cognitive Psychology, 36*(2), 433–444.
<https://doi.org/10.1002/acp.3933>
- Hunter, A. S., & Lloyd, M. E. (2018). Faculty discuss study strategies, but not the best ones: A survey of suggested exam preparation techniques for difficult courses across disciplines. *Scholarship of Teaching and Learning in Psychology, 4*(2), 105–114.
<https://doi.org/10.1037/stl0000107>
- Kirk-Johnson, A., Galla, B. M., & Fraundorf, S. H. (2019). Perceiving effort as poor learning: The misinterpreted-effort hypothesis of how experienced effort and perceived learning relate to study strategy choice. *Cognitive Psychology, 115*, 1–31.
<https://doi.org/10.1016/j.cogpsych.2019.101237>
- Kornell, N., & Bjork, R. A. (2007). The promise and perils of self-regulated study. *Psychonomic Bulletin & Review, 14*(2), 219–224. <https://doi.org/10.3758/BF03194055>
- Kornell, N. & Bjork, R. A. (2008). Learning concepts and categories: Is spacing the “enemy of induction”? *Psychological Science, 19*(6), 585–592. <https://doi.org/10.1111/j.1467-9280.2008.02127.x>
- Kornell, N. (2009). Optimising learning using flashcards: Spacing is more effective than cramming. *Applied Cognitive Psychology, 23*(9), 1297–1317.
<https://doi.org/10.1002/acp.1537>
- Krueger, L., Dyer, J., Schroeder, J. L., & Carlini, P. M. (2023). Should students or instructors provide opportunities for testing and why?: A mixed methods approach. *College Student Journal, 56*(4), 351–357.

- Lloyd, J. W., Cantner, C. A., Mariani, V., Greenhill, L. M., Haden, N. K., Tucker-Lively, F., & Chaddock, H. M. (2020). AAVMC faculty development needs assessment – 2019. AAVMC. https://www.aavmc.org/assets/Site_18/files/About_AAVMC/AAVMC-Monograph-FacultyDevelopment.pdf
- McAndrew, M., Kamboj, R. S., & Pierre, G. C. (2015). Do Dental Students Use Optimal Study Strategies? *Journal of Dental Education*, 79(1), 33–37. <https://doi.org/10.1002/j.0022-0337.2015.79.1.tb05854.x>
- McCabe, J. (2011). Metacognitive awareness of learning strategies in undergraduates. *Memory and Cognition*, 39(3), 462–476. <https://doi.org/10.3758/s13421-010-0035-2>
- McCabe, J. A., & Lummis, S. N. (2018). Why and how do undergraduates study in groups? *Scholarship of Teaching and Learning in Psychology*, 4(1), 27–42. <https://doi.org/10.1037/stl0000099>
- Miyatsu, T., Nguyen, K., & McDaniel, M. A. (2018). Five popular study strategies: Their pitfalls and optimal implementations. *Perspectives on Psychological Science*, 13(3), 390–407. <https://doi.org/10.1177/1745691617710510>
- Morehead, K., Rhodes, M. G., & DeLozier, S. (2016). Instructor and student knowledge of study strategies. *Memory*, 24(2), 257–271. <https://doi.org/10.1080/09658211.2014.1001992>
- Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest*, 9(3), 105 – 119. <https://doi.org/10.1111/j.1539-6053.2009.01038.x>
- Pass, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist*, 38(1), 1–4. https://doi.org/10.1207/S15326985EP3801_1

- Piza, F., Kesselheim, J. C., Perzhinsky, J., Drowos, J., Gillis, R., Moscovici, K., Danciu, T. E., Kosowska, A., & Gooding, H. (2019). Awareness and usage of evidence-based learning strategies among health professions students and faculty. *Medical Teacher, 41*(12), 1411–1418. <https://doi.org/10.1080/0142159X.2019.1645950>
- Rhodes, M. G., Cleary, A. M., & DeLosh, E. L. (2020). *A guide to effective studying and learning: Practical strategies from the science of learning*. Oxford University Press.
- Rivers, M. L. (2021). Metacognition about practice testing: A review of learners' beliefs, monitoring, and control of test-enhanced learning. *Educational Psychology Review, 33*(3), 823–862. <https://doi.org/10.1007/s10648-020-09578-2>
- Roediger, H. L., and Karpicke, J. D. (2006). Test-enhanced learning: taking memory tests improves long-term retention. *Psychological Science, 17*(3), 249–255. <https://doi.org/10.1111/j.1467-9280.2006.01693.x>
- Rowland, C. A. (2014). The effect of testing versus restudy on retention: A meta-analytic review of the testing effect. *Psychological Bulletin, 140*(6), 1432–1463. <https://doi.org/10.1037/a0037559>
- Sana, F., & Yan, V. X. (2022). Interleaving Retrieval Practice Promotes Science Learning. *Psychological Science, 33*(5), 782–788. <https://doi.org/10.1177/09567976211057507>
- Shobe, E. (2022). Achieving Testing Effects in an Authentic College Classroom. *Teaching of Psychology, 49*(2), 164–175. <https://doi.org/10.1177/00986283211015669>
- Spitzer, H. F. (1939). Studies in retention. *The Journal of Educational Psychology, 30*(9), 641–656. <https://psycnet.apa.org/doi/10.1037/h0063404>

- Suda, K. J., Bell, G. C., & Franks, A. S. (2011). Faculty and student perceptions of effective study strategies and materials. *American journal of pharmaceutical education*, 75(10), 1-6. <https://doi.org/10.5688/ajpe7510201>
- Surma, Camp, G., de Groot, R., & Kirschner, P. A. (2022). Novice teachers' knowledge of effective study strategies. *Frontiers in Education*, 7, 1–16. <https://doi.org/10.3389/feduc.2022.996039>
- Susser, J. A., & McCabe, J. (2013). From the lab to the dorm room: metacognitive awareness and use of spaced study. *Instructional Science*, 41(2), 345–363. <https://doi.org/10.1007/s11251-012-9231-8>
- Willingham, D. T., Hughes, E. M., & Dobolyi, D. G. (2015). The scientific status of learning styles theories. *Teaching of Psychology*, 42(3), 266-271. <https://doi.org/10.1177/0098628315589505>
- Wissman, K. T., & Rawson, K. A. (2016). How do students implement collaborative testing in real-world contexts? *Memory*, 24(2), 223–239. <https://doi.org/10.1080/09658211.2014.99979>
- Wissman, K. T., Rawson, K. A., & Pyc, M. A. (2012). How and when do students use flashcards? *Memory*, 20(6), 568–579. <https://doi.org/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(3), 140–152. <https://doi.org/10.1016/j.jarmac.2014.04.003>
- Yang, C., Luo, L., Vadillo, M. A., Yu, R., & Shanks, D. R. (2021). Testing (quizzing) boosts classroom learning: A systematic and meta-analytic review. *Psychological Bulletin*, 147(4), 399–435. <https://doi.org/10.1037/bul0000309>

Zechmeister, E.B., & Shaughnessy, J.J. (1980). When you know that you know and when you think that you know but you don't. *Bulletin of the Psychonomic Society*, 15(1) 41–44.

<https://doi.org/10.3758/BF03329756>

APPENDICES

Appendix A. Survey Questions for Instructors

Demographic Questions

- Have you previously or currently teach veterinary students? (will indicate if survey will move forward)
 - Y/N
- What is your age?
 - Blank box
- What is your gender identity?
 - Male
 - Female
 - Non-Binary/third gender
 - Other: _____
 - Prefer not to say
- What racial or ethnic group(s) best describe you? (select all that apply)
 - White/Caucasian
 - Black or African American
 - American Indian or Alaska Native
 - Asian
 - Native Hawaiian or Pacific Islander
 - Hispanic or Latino
 - Other: _____
 - Prefer not to say
- How many years have you been teaching?
 - Blank box
- What veterinary school do you teach at?
 - Dropdown
- Select what year(s) of veterinary students you teach: (select all that apply)
 - First Year
 - Second Year
 - Third Year
 - Fourth Year
- What is your position?
 - Assistant Professor
 - Associate Professor
 - Professor
 - Adjunct Instructor
 - Clinical Instructor
 - Intern/Resident

- Other: _____
- What is your primary teaching environment?
 - Classroom
 - Online
 - Laboratory
 - Clinical
 - Field
 - Hybrid
- Have you received any teacher education training? (e.g., teaching seminars, teaching professional development workshops, online teaching courses)
 - Yes
 - No
 - If Y: What type of training did you receive?
 - Blank box
- Are you interested to learn more about teaching and instructional strategies?
 - Definitely not
 - Probably not
 - Might or might not
 - Probably yes
 - Definitely yes

Learning Strategy Questions

1. Do you discuss learning techniques in class?
 - a. Yes
 - b. No
2. If Y: How often do you discuss learning techniques?
 - a. A few times a week
 - b. About once a week
 - c. Before tests/major assignments
 - d. About once every semester
 - e. Other: _____
3. What testing format do you use the most often?
 - a. Essay/short answer exams
 - b. Multiple-choice exams
 - c. About the same
 - d. Other: _____
4. Why do you use this testing format? (select all that apply)
 - a. Ease, simplicity of grading
 - b. Ease, simplicity of item construction
 - c. Captures key constructs from class
 - d. Encourages better student learning
 - e. To match the NAVLE format
 - f. Other: _____

5. How often do you provide quizzes to your students?
 - a. A few times a week
 - b. About once a week
 - c. Every few weeks
 - d. A couple times a semester
 - e. I don't provide quizzes
 - f. Other: _____
6. How do you think your students choose to study?
 - a. Whatever's due soonest/overdue
 - b. Whatever they haven't studied for the longest time
 - c. Whatever they find interesting
 - d. Whatever they feel they're doing the worst in
 - e. Based on a planned study schedule
7. How do you think your students **should** choose to study?
 - a. Whatever's due soonest/overdue
 - b. Whatever they haven't studied for the longest time
 - c. Whatever they find interesting
 - d. Whatever they feel they're doing the worst in
 - e. Based on a planned study schedule
8. Do you return to earlier material in later sections? (e.g., reviewing week 1 material near the middle of the semester)
 - a. Yes
 - b. No
9. Do you recommend learning techniques to students, either in class or during out of class meetings?
 - a. Yes
 - b. No
10. If Y: Which of the following learning techniques do you recommend students use regularly? (please check all that apply)
 - a. Test yourself with questions or practice problems
 - b. Use flashcards
 - c. Recopy your notes
 - d. Reread chapters, articles, notes, etc.
 - e. Make outlines
 - f. Underline or highlight while reading
 - g. Make diagrams, charts or pictures
 - h. Study with friends
 - i. 'cram' lots of information the night before the test
 - j. Ask questions or verbally participate during class
 - k. Other: _____
11. If Y: Do you think students use those learning techniques?
 - a. Yes
 - b. Yes, for my class, but not necessarily for others

- c. No
 - d. Some do, some do not
12. 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?
- a. They will learn more that way than through rereading
 - b. To figure out how well they have learned the information they're studying
 - c. I do not think quizzing will necessarily benefit students
13. 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)
- a. Yes
 - b. No
14. Do you believe students have different learning styles (e.g., visual vs. auditory learners)?
- a. Yes
 - b. No
15. If Y: If yes, do you teach to accommodate those differences?
- a. Yes
 - b. No
16. How likely would you be to do each of the following for students struggling in physiology courses? (Response options: extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely and extremely likely)
- a. Explain that not everyone has "physiology talent" - some people are better able to understand intangible concepts and some people are not
 - b. Console the student for the grade by telling them plenty of people have trouble in physiology but go on to be very successful in other fields.
 - c. Explain that not everyone is meant to pursue a career in physiology.
 - d. Assign less physiology homework.
 - e. Talk to the student about dropping the class.
 - f. Offer suggestions for how to study more effectively.

Learning Strategy Scenarios

The following questions involve school scenarios where two different learning strategies are used. On a scale from 1 to 7 (1 being not beneficial and 7 being the most beneficial) list how helpful you think the two strategies in each scenario would be.

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 2 weeks, all students are asked to list the cranial nerves in order.

Assignment A: 1 2 3 4 5 6 7

Assignment B: 1 2 3 4 5 6 7

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.

Slideshow A: 1 2 3 4 5 6 7

Slideshow B: 1 2 3 4 5 6 7

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.

Presentation A: 1 2 3 4 5 6 7

Presentation B: 1 2 3 4 5 6 7

In two different classes, a scientific article about a specific topic is presented. In **Class A**, students first study the article for 7 minutes, and then are asked to write down from memory as much of the material from the article as they can. In **Class B**, students first study the article for 7 minutes, and then are asked to study the article again for another 7 minutes. After 1 week, all students are asked to recall as much of the scientific article as they can remember.

Class A: 1 2 3 4 5 6 7

Class B: 1 2 3 4 5 6 7

Two pathology professors present 6 pathology gross pictures each of 12 types of gross changes (72 pictures total). **Professor A** presents all 6 gross pictures of the gross change consecutively (i.e., grouped), and then moves on to the next 6 pictures of another gross change, and so on, until all pictures have been presented. **Professor B** presents the various types of gross changes in an intermingled fashion (i.e., mixed), such that a single gross picture of a gross change would be

followed by a different gross change picture, and so on, until all gross pictures have been presented. After viewing the gross pictures, a test is given that requires matching new gross pictures to the gross changes that were studied.

Professor A: 1 2 3 4 5 6 7

Professor B: 1 2 3 4 5 6 7

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 everyday. Both students spend the same total amount of hours studying.

Student A: 1 2 3 4 5 6 7

Student B: 1 2 3 4 5 6 7

Do you have any comments on learning techniques? This may include your view on the best methods to learn, how you think students do/should study, why you think students study the way they do?

- Blank Box

Appendix B. Summary of Instructors' Free Responses

	<i>Questions</i>	<i>Categorized Responses</i>	<i>Percentage</i>	<i>Frequency</i>
2	If Y: How often do you discuss learning techniques?	Beginning of semester and before tests	24%	6/25
		A few times a semester	16%	4/25
		Every few weeks	16%	4/25
		Depends on setting of class	12%	3/25
		As needed	12%	3/25
		Posted in syllabus or online	8%	2/25
		Other	12%	3/25
3	What testing format do you use the most often?	Another type of production (fill-in-the-blank, interview, clinical rounds, essay, oral)	20%	17/86
		Another type of recognition (T/F, matching)	3%	3/86
		Unspecified mix	22%	19/86
		Does not administer test	20%	17/86
		Observation test	21%	18/86
		Depends on course	8%	7/86
		Unspecified assignments or projects	6%	5/86
4	Why do you use this testing format?	Most appropriate or demonstrates competency/best assessment	23%	24/104
		Required, encouraged, or best fits software	34%	35/104
		Most objective or allows for analysis/metrics	10%	10/104
		No support/time to grade otherwise	8%	8/104
		No exams/don't write exams	13%	13/104
		Other	13%	13/104
5	How often do you provide quizzes to your students?	Every lecture/session	40%	17/42
		Depends on the class	17%	7/42
		One per module	14%	6/42
		Not Applicable	17%	7/42
		Other	12%	5/42
10	If Y: Which of the following learning techniques do you recommend students use regularly?	Think of how this applies	11%	7/63
		Teach others/create test questions	14%	9/63
		Hands-on practice/role play	10%	6/63
		Study in groups	6%	4/63
		Attend class/office hours/review sessions	6%	4/63
		Reread or repetition	10%	6/63

<i>Questions</i>	<i>Categorized Responses</i>	<i>Percentage</i>	<i>Frequency</i>
	Pick out key concepts/reflect	11%	7/63
	Differs by student/learning style	8%	5/63
	Take written notes	6%	4/63
	Spacing study out	5%	3/63
	Other	13%	8/63
Do you have any comments on learning techniques? This may include your view on the best methods to learn, how you think students do/should study, why you think students study the way they do? (many responses fit into multiple categories)	Supporting ES learning strategies	44%	81/186
	Amount of material; Time/Pace	20%	38/186
	Supporting learning styles	32%	59/186
	Students struggling or observations of students	24%	45/186
	Case-based application	23%	42/186
	Notes about own program	8%	15/186
	Group learning benefits	8%	14/186
	Students don't know or self wants to know more	13%	25/186
	Reference to survey	10%	19/186
	No comment	1%	2/186