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## The Effect of Reflection on Retrieval Practice to Self-Regulated Learning

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# The Effect of Reflection on Retrieval Practice to Self-Regulated Learning

## Abstract

This action research study investigated the relationship between reflection on retrieval practice quizzes and its effect on students' ability to self-regulate their learning. Participants in this study included 33 students from a school in California in an honors anatomy and physiology course. Students took an initial survey about self-regulation and participated in retrieval practice quizzes for eight weeks. The experimental group also intentionally practiced reflection during and after the quizzes. The same self-regulated learning survey was conducted at the conclusion of the study and the results were analyzed. The results of the study show reflection on retrieval practice had no statistical significance in the ability of students to self-regulate their learning.

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Action Research Report Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Education

**The Effect of Reflection on Retrieval Practice to  
Self-Regulated Learning**

by

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Action Research Report

Submitted in Partial Fulfillment

of the Requirements for the

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**Abstract**

This action research study investigated the relationship between reflection on retrieval practice quizzes and its effect on students' ability to self-regulate their learning. Participants in this study included 33 students from a school in California in an honors anatomy and physiology course. Students took an initial survey about self-regulation and participated in retrieval practice quizzes for eight weeks. The experimental group also intentionally practiced reflection during and after the quizzes. The same self-regulated learning survey was conducted at the conclusion of the study and the results were analyzed. The results of the study show reflection on retrieval practice had no statistical significance in the ability of students to self-regulate their learning.

*Keywords:* Reflection, Retrieval Practice, Self-regulated Learning



Reflection is a powerful tool that helps learners make meaning from their experiences. However, in today's fast-paced world, pausing to think about thinking is not always a daily habit. Each day students across the world are asked to remember ideas and apply their thinking to new situations and teachers are tasked with helping students learn how to learn. As the expert learner in the classroom, teachers help students grow in their capacity to remember, learn, and transfer ideas. Reflection is one metacognitive monitoring tool that can help students identify their thinking strategies and plan their next steps for learning.

Retrieval practice is a proven learning strategy that can boost student performance. "The act of retrieving information from memory on a practice test increases retention of information on a subsequent assessment" (Cogliano et al., 2021, p. 1422). When students are asked to retrieve information, they are forced to bring ideas into working memory, an act that can inform learners about what they already know and enable them to identify gaps in knowledge. Students who engage in retrieval practice typically outperform students who do not (Ariel & Karpicke, 2017; Carpenter et al., 2015; Nwafor et al., 2015). Agarwal (2020) suggested retrieval practice is an easy, cost-effective, low-prep, no-grading strategy any teacher can use anywhere to help students "pull" ideas out of their memory. Using cognitive science in the classroom is an effective tool teachers can use to help students not only remember information, but also learn it. Retrieval practice strategies are demanding; this "desirable difficulty" leads to long-term learning as opposed to a short-term learning strategy like cramming which is not as demanding (Agarwal, 2020). Retrieval practice has been shown to be effective at all school-age levels (Kenney & Bailey, 2021).

Another powerful tool that can be used to increase student performance is feedback. Feedback can come from external sources like a teacher, or it can be self-generated. As students

develop, it is increasingly important that they learn how to utilize both kinds of feedback to enhance their learning. Feedback helps to close the gap between what students have learned and what still needs to be learned. Of particular significance is formative assessment because both the teacher and students can use information to make adjustments to teaching and learning.

“Students begin to understand their intended learning goals, develop their skills to make judgments about the learning in relation to a learning standard or instructional outcome, and implement a variety of strategies to regulate their learning” (Hudseman et al., 2013, p. 3). When educators teach students how to respond to feedback, monitor their progress, and plan their next steps, they are training their students to be life-long learners who are self-regulated.

Self-regulated learners are those that are personally responsible for their learning. They take initiative in three main areas of their learning: metacognition, motivation, and behavior. Zimmerman (1990) stated that these learners “plan, set goals, organize, self-monitor, and self-evaluate at various points during the process of acquisition” (pp. 4-5). These students are aware of strategies they can use to achieve goals and use feedback loops to help them determine the effectiveness of their learning. They are highly motivated individuals that consistently monitor their thinking and behavior and as a result increase their academic performance which increasingly motivates them to learn more.

### **Purpose of the Study**

The purpose of this study is to examine how reflection on retrieval practice quizzes influences student self-regulation. Students often see assessments like quizzes as a measurement of learning, not as learning itself. When students take an active role in reflection on their performance and learning, assessment tools like quizzes can become tools for learning. As

consumers of assessment information, students can make adjustments to their learning and study habits and thus effectively self-regulate. They can study smarter, not harder.

### **Research Question**

Can reflection on retrieval practice develop self-regulated learners?

### **Definition of Terms**

The following definitions will be used to explain the terms. Unless otherwise noted, definitions are the author's ideas.

Feedback: information about how evidence of learning compares to a standard. Can be internal feedback (given by learner) or external feedback (given by teacher or other outside source).

Feedback-Driven Metacognition: student reflection on what is understood well and what still needs to be learned based on external or internal feedback (Agarwal, 2020)

Metacognition: an ability to think about one's own thinking (Osterhage et al., 2019)

Monitor: an aspect of metacognition where students self-evaluate understanding or performance

Practice quiz: an ungraded multiple choice quiz checked for answer accuracy

Reflection: action learners take when monitoring and assessing their understanding during the learning process

Retrieval Practice: any activity that causes students to practice their knowledge and bring information to mind (Agarwal, 2020)

Self-Regulated Learning: Process by which individuals develop goals, select learning strategies, and monitor their performance (Osterhage et al., 2019)

### **Literature Review**

Students learn both course content and skills at school; they learn what to think and how to think. Learning how to be an efficient learner is a process that develops over time and takes

years of practice. Self-regulated learning is important because learners become aware of their strengths and weaknesses and utilize a collection of strategies to adjust their learning.

Self-regulated learners use feedback, monitoring, and reflection as tools that enable them to plan strategies to help them attain their academic goals. Nwafor et al., (2015) stated that learners who are aware of their learning recognize that intelligence is not fixed and that “opportunities to take on challenging tasks, practice their learning, develop a deep understanding of subject matter, and exert effort will give rise to academic success” (p. 45). What sets a good student apart from the rest is their ability to think about their thinking, or metacognitive awareness, and their ability to set goals, plan, monitor, and self-evaluate. Rivers (2021) suggested that “knowing how to assess and manage one’s own learning is critical for becoming an efficient and effective learner” (p. 824).

Many high school students aspire to continue their education at college, but often lack the metacognitive skills necessary for success and many need to take a developmental course to make up for the lack of these necessary skills (Hudesman et al., 2013). Tanner (2012) asserted that metacognition is a skill that should be explicitly taught, especially since “we are continually surprised at the number of students who come to college having very little metacognitive knowledge; knowledge about different strategies, different cognitive tasks, and particularly, accurate knowledge about themselves” (Pintrich, 2002, as cited in Tanner, 2012, p. 114). The Next Generation Science Standards hold metacognitive skills and self-efficacy in relationship to the practice of science as essential for college-ready students (NGSS Lead States, 2013).

Metacognition enables learners to effectively self-evaluate knowledge and understanding so they can make appropriate adjustments to the strategies they use to help them learn and study. As high school students transition into more independent forms of learning at college and

beyond, they need to rely on their own metacognition to guide their learning. When Lavi et al. (2019) conducted a literature review of metacognition in high school science education, they concluded that students can be autonomous agents in their learning process if they compare, reflect, and evaluate their understanding. It is important for students to monitor their learning and reflect on their progress in order to gain self-regulatory skills (Rivers, 2021). Rivers (2021) elaborated on the significance of self-regulation and maintained that students often have misconceptions about how to monitor their learning and have incorrect beliefs about how to manage their own learning, which often lead to student overconfidence. Numerous studies also confirmed this claim (Ariel & Karpicke, 2018; Chen et al., 2019; Cogliano et al., 2021; Kenney & Bailey, 2021; Osterhage et al., 2019). Similarly, Osterhage et al., (2019) revealed that many students unrealistically expect they will receive good grades and therefore become disappointed when reality doesn't match their expectations. She and her team asked students in an introductory undergraduate biology course to predict their exam scores. Students took the exam and their performance was compared to their prediction. Students whose actual scores differed from their predicted scores by 10 % or more were labeled "miscalibrated." It was found that 59.7% of these students were miscalibrated because they overestimated their actual performance. Carpenter et al., (2015) found that lower performing university students tended to overpredict their exam performance by 12 percentage points whereas higher performing students were a closer match, overestimating their performance by 6%. Overconfidence impairs student self-evaluation; students stop studying because they incorrectly assume they have adequately prepared for the exam. Students can, however, be taught how to self-regulate and adjust their habits to increase performance.

Correcting misconceptions about how to monitor and manage learning are important steps in the development of self-regulation. Osterhage et al., (2019) concluded that accurate self-reflection and self-evaluation are critical for learning and, therefore, key steps to the development of a self-regulated learner. Nix and Wyllie (2011) demonstrated that students who self-evaluated by rating correct answer confidence to course questions employed higher-order thinking because students paused to reflect and justify their decisions. They stated that “while not all students are good at self-assessment, they may still benefit from the prompted reflection” (p. 111). A correct answer with low confidence does not suggest that the students understand the information and should prompt re-study, but not all students know how to approach these learning opportunities. Cogliano et al. (2021) similarly suggested “poor self-monitoring capacity necessarily entails poor selection and execution of relevant control processes: If you do not know what you do not know, you cannot rectify your ignorance” (Benjamin et al., 1998 as cited in Cogliano et al., 2021, p. 1436).

Retrieval practice is a strategy that can promote learning and self-regulation. Many students do not effectively use retrieval practice as a monitoring or learning strategy, but see it solely as an assessment tool (Ariel & Karpicke, 2018; Cogliano et al., 2021; Kenney & Bailey, 2021). Often, students are not able to self-regulate their use of this technique effectively as a result of these misconceptions. Numerous studies (Badali et al., 2022; Cogliano et al., 2021; Nix & Wyllie, 2011) found that university students needed help and guidance to use retrieval practice as a learning and study technique. Badali et al. (2022) tested whether or not participants could effectively self-regulate their use of retrieval practice as a function of item difficulty. The experimental group participants were given freedom to choose whether to study a Lithuanian-English translation word pair, take a practice test, or drop the word pair from

practice. The control group was assigned a learning schedule and completed practice tests until they reached a successful criterion (1, 3, or 5 recalls retrieved correctly). There was a mixture of easy and difficult words in the 60 word pair translations and students were instructed to learn all 60 word pairs correctly; their memory would be tested two days after the study session. During the study session, students made both an ease of learning judgment (EOL) and a judgment of learning (JOL) for each item. The experimental group chose to self-test difficult items more often than easy items, but dropped both easy and difficult items from study after about one correct recall. On the delayed memory test two days later, participants in the experimental group were able to recall 27% of the difficult word pairs correctly, whereas the participants in the success criterion group recalled 67% of the difficult word pairs correctly. The researchers concluded that if the experimental group had continued to practice, the participants could have performed better, and thus concluded that participants did not effectively self-regulate their use of retrieval practice to enhance performance. The group extended their study by forming new experimental groups, one of those experimental groups will be discussed here. Participants were given labels of “easy” or “difficult” for each word pair, were given a goal to achieve (70% correct on recall test), and were asked to plan their learning by reflecting on what an optimal student should do and what they planned to do during their study sessions. These participants indicated an optimal student should recall a difficult word pair five times before dropping it from study and retrieve an easy word pair four times before dropping it from study and planned to do so accordingly. However, those participants did not effectively carry out their learning plan; they actually recalled both easy and difficult words only about one time. On the recall test two days later, these participants again demonstrated that they did not effectively self-regulate their use of

practice testing because the difference in performance outcomes between easy and difficult word pairs was still significant (easy=65% correct, difficult=40% correct).

A similar study was conducted by Ariel and Karpicke (2018) and they stated, “assuming that students use retrieval practice ineffectively because they lack appropriate metacognitive knowledge, correcting this knowledge could lead to improved self-regulatory behavior” (p. 44). Their study found that the simple intervention of instructing students to correctly retrieve information three times before dropping a concept from study was able to not only enhance recall (experimental group  $M=0.87$ , control group  $M=0.64$ ), but also changed their behavior. Students continued to use retrieval practice strategies when learning new material one week later. This suggested a shift in self-regulation. Nwafor et al., (2015) found that students who were instructed by teachers that promoted self-regulation scored 15 points higher than students taught with more conventional means. This demonstrated that learners who take responsibility for their own learning are able to appropriately self-regulate and therefore achieve more. Chen et al., (2019) highlighted that “students may benefit from practice tests prior to an exam, which not only improve their exam performance, but also allow for better metacognitive monitoring based on their subjective experience during the practice test” (p. 5). Students who are instructed to reflect on their performance during retrieval practice are better able to monitor their learning, make adjustments, and persist in their learning, therefore increasing their self-regulation.

Retrieval practice used in conjunction with a metacognitive intervention helps students self-regulate their learning. Littrell-Baez et al. (2015) argued that retrieval practice can encourage students to develop metacognitive skills that will improve students’ ability to monitor their performance and regulate study strategies. They suggested that teachers explicitly instruct students to reflect on their retrieval practice experience to monitor their learning; when



corrective feedback was part of the reflection, students received long-term learning gains for initially correct answers and gained the opportunity to adjust their incorrect responses. Students benefit from instruction and support to develop these reflective skills which promote self-regulation (Nix & Wyllie, 2011). Nix and Wyllie (2011) found that students needed prompting to reflect on their retrieval practice and encouragement to provide themselves feedback that would be beneficial when restudying. Hudesman et al. (2013) found that college students in a developmental math course benefited from feedback reflection on quizzes. Students in their study took content-based quizzes, predicted their grades, recorded the amount of time they spent preparing for the quiz, and made confidence judgments for each question. After receiving their grades and instructor feedback, students reflected on their performance and designed a plan for improving their work in addition to solving the math problems again. Students in the course sections of this developmental math class that included these metacognitive interventions had a pass rate of 78% compared to a 49% pass rate for the traditional developmental math course. The researchers continued to follow the original cohort of students in their study and found that when the students in the metacognitive interventions group continued to other college-credit math courses, 62% of them passed, whereas 25% of the students in the traditional instructional group passed college-credit math. This demonstrated the durability of the metacognitive intervention for these students and thus growth in their ability to self-regulate.

Cogliano et al. (2021) discovered the significance of instructing students to effectively use retrieval practice feedback to not only monitor learning, but to self-regulate it. In their study, college students took practice tests, received feedback, and monitored which topics were well-learned and which were yet-to-be-learned. In addition, the experimental group participated

in metacognitive training about retrieval practice. The students were first provided with information about the benefits of retrieval practice and were taught how to use it. Next, they were provided with instruction on how to enhance their learning by practicing feedback-driven metacognition. Finally, students learned how to evaluate external feedback and were taught to self-evaluate their performance by considering items they were confident about and got correct, items they were less confident about but still got correct, and items that were incorrect. These trainings were embedded within the context of an undergraduate psychology course. Students in the experimental group showed increased exam performance as compared to the control group who did not receive the training (experimental  $M=80.67$ , control  $M=70.63$ ).

Low-stakes retrieval practice has been shown to promote self-regulation because it forces students to evaluate their memory and the durability of their understanding (Kenney & Bailey, 2021). Kenney and Bailey (2021) found that students who participated in ungraded daily review quizzes were able to monitor their learning and more accurately rate their answer confidence compared to students who did not participate in the retrieval practice. Content questions that were asked both in daily review and on the final exam were answered more accurately than questions that were not practiced with any kind of retrieval practice strategy. This was evidenced by the difference between confidence rating and percent earned on the exam; results closer to zero (daily review + exam  $M=2.23$ , no practice  $M=7.59$ ) were more accurate. Barenberg and Dutke (2019) found that students who engaged in retrieval practice quizzes were more confident about their responses on a final test than those who did not participate in practice quizzes. They stated “the results on metacognitive performance also indicate beneficial effects on the accuracy of metacognitive monitoring that is highly relevant in supporting effective self-regulated learning processes” (p. 277). Gjerde et al. (2021) as well as McKenna et al. (2019) also concluded

similarly that students who participated in retrieval practice gained beneficial study strategies because they reflected on their progress in learning. This feedback about their progress promoted self-regulation.

In conclusion, students who engaged in retrieval practice in tandem with an intervention that encouraged reflection and monitoring were better able to self-regulate. Metacognitive awareness and feedback about performance during retrieval practice enhanced self-regulation. The correlation between increased academic performance and reflection on retrieval practice demonstrated changes in students' ability to plan, monitor, and self-evaluate their learning which are functions of a self-regulated learner. Students who are exposed to these interventions not only gained the benefits of increased academic performance, but also likely gained the skills necessary to be life-long learners.

## **Methods**

### **Participants**

Participants of this research study were students in an honors anatomy and physiology course during the 2022-2023 school year. Students were in grades 11 or 12 with an average age of 17.4 years old at the time of study. Fifteen males and eighteen females were participants. The control group was composed of eight females and seven males. The experimental group was made up of ten females and eight males. The majority of students were of Caucasian background, while about 15% of the participants represented minority backgrounds. One student did not have English as a first language. Students in this private, Christian school were generally of middle class family background. The high school is part of a pre K-12 school system set in a rural/suburban community in California.

## Design

This study analyzed the relationship between reflection on retrieval practice quizzes and growth in self-regulation between two class sections taught by the same teacher. The control group was a group of 15 students (7 males, 8 females) who received retrieval practice quizzes and course content in “class as usual.” The experimental group was a group of 18 students (8 males, 10 females) who received the retrieval practice quizzes and a reflection intervention in addition to course content. The independent variable was the reflection intervention. The dependent variable was the change in self-regulation as measured with survey scores. Changes in behavior throughout the study were measured through a self-reported study strategy/test preparation inventory. A researcher-generated survey was conducted after the study to capture additional information and behavioral changes that could not be represented with data alone to both the control and experimental groups.

## Materials

The self-regulation formative survey (Gaumer Erickson et al., 2018) was administered to students using student devices and accessed online through the Research Collaboration (<https://cccframework.org>). The survey was piloted and tested by the Research Collaboration and found to be highly reliable ( $\alpha = .894$ ) and internally consistent ( $\alpha = .86$ ) (Gaumer Erickson et al., 2018). This self-report measure asked students to rate their behaviors on a 5-point Likert-type scale. Retrieval practice quizzes were written by the researcher and connected to course learning goals. The reflection intervention was designed by the researcher and modeled after similar reflection interventions conducted by Hudesman et al., 2013 and Nix and Wyllie, 2011. The post-intervention survey was written by the researcher.

**Procedure**

Students were given the self-regulation formative survey and their scores calculated as a raw score. Students in the experimental group were instructed about self-regulated learning and were taught how to use the reflection tool in connection with retrieval practice quizzes. The retrieval practice quizzes were administered with course content twice a week for eight weeks; the quizzes were not graded for points in the students' cumulative grades. Quizzes were administered electronically during class time using Google Forms on student devices. Students received immediate feedback about their performance and could take the retrieval practice quizzes numerous times before the unit test. During and after the quizzes, the experimental group participated in the reflection intervention. Prior to unit tests, students were asked to report on their study strategies and test preparation to measure behavioral change in regards to self-regulation. At the conclusion of the eight weeks, the same self-regulation formative survey was again administered and raw scores calculated and compared to the initial scores.

After the study was completed, an additional survey was conducted to collect the impressions and experiences of the participants in the study. The reflections and commentary provided the researcher with another angle to study the growth in self-regulation that could not be captured with numbers alone. Students in both the control and experimental groups were given the written survey during class time and asked to complete it via Google Forms. The experimental group's survey included open-ended questions about their impressions and use of the reflection tool. Student names were not collected with the survey, so responses were held anonymously.

### **Results**

The purpose of this study was to determine if reflection on retrieval practice had an impact on students' ability to self-regulate their learning. A self-regulated learning survey was given to students in control and experimental groups prior to implementation of retrieval practice. While retrieval practice was consistent among the two groups, the experimental group was given a reflection tool to utilize alongside the retrieval practice. The same survey was administered to both groups after eight-weeks of retrieval practice. A t-test was conducted on both the control and experimental groups to determine if there was any significance between the initial and final scores of the self-regulated learning survey. An alpha level of 0.05 was used to determine statistical significance.

**Table 1***Experimental Group Self-Regulated Learning Scores*

Student	Initial Survey	Final Survey	Difference
1	64	52	-12
2	69	61	-8
3	72	76	4
4	78	85	7
5	69	69	0
6	85	94	9
7	80	86	6
8	72	76	4
9	87	89	2
10	81	83	2
11	68	70	-2
12	77	72	-5
13	76	64	-12
14	82	78	-4
16	93	90	-3
17	69	85	19
18	74	71	-3
19	65	66	1
Mean	75.6	75.9	0.278
SD	7.98	11.31	7.60
p-value	0.85		

**Table 2***Control Group Self-Regulated Learning Survey Scores*

Student	Initial Survey	Final Survey	Difference
19	77	72	-5
20	79	93	17
21	77	82	5
22	90	97	7
23	82	87	5
24	84	83	-1
25	83	70	-13
26	74	75	1
27	89	81	-8
28	90	88	-2
29	81	87	6
30	60	67	7
31	78	65	-13
32	83	87	4
33	71	72	1
Mean	79.87	80.4	0.73
SD	7.84	9.74	8.08
p-value	0.79		

Tables 1 and 2 demonstrate that eight students in the experimental group increased their final survey scores and eight students had final survey scores that were lower than the initial survey scores while one student neither increased nor decreased. The largest increase in the experimental group was 19 points; the greatest decrease was 12 points. Nine students in the

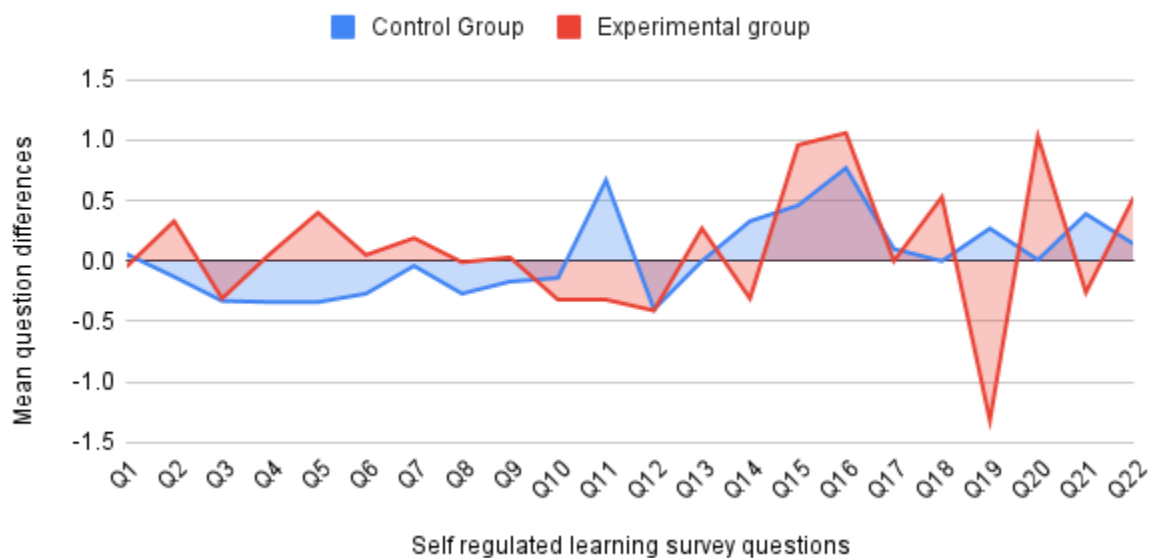


control group had final survey scores higher than the initial survey scores while six students decreased their final survey scores compared to the initial survey. The largest increase was 17 points; the largest decrease was 13 points. The average change exhibited in the experimental group was an increase of 0.27. The average change in the control group was an increase of 1.71. A paired sample t-test was conducted on the initial and final scores to determine if the difference of the intervention was statistically significant. As seen in Tables 1 and 2, the t-test revealed that the treatment did not make a significant difference in self-regulation within each group; the control group had a p-value of 0.85 and the experimental group had a p-value of 0.79. A two sample t-Test was conducted to compare the final survey scores among the two groups; a p-value of 0.177 was calculated, which is not statistically significant. Figure 1 shows changes in initial and final survey scores among students of control and experimental groups.

### Figure 1

*Summary of initial and final survey question changes in control and experimental groups*

#### Mean control and experimental group changes in initial and final survey by question



The self-regulated learning survey was designed to address each aspect of self-regulated learning: plan, monitor, adjust, and reflect.

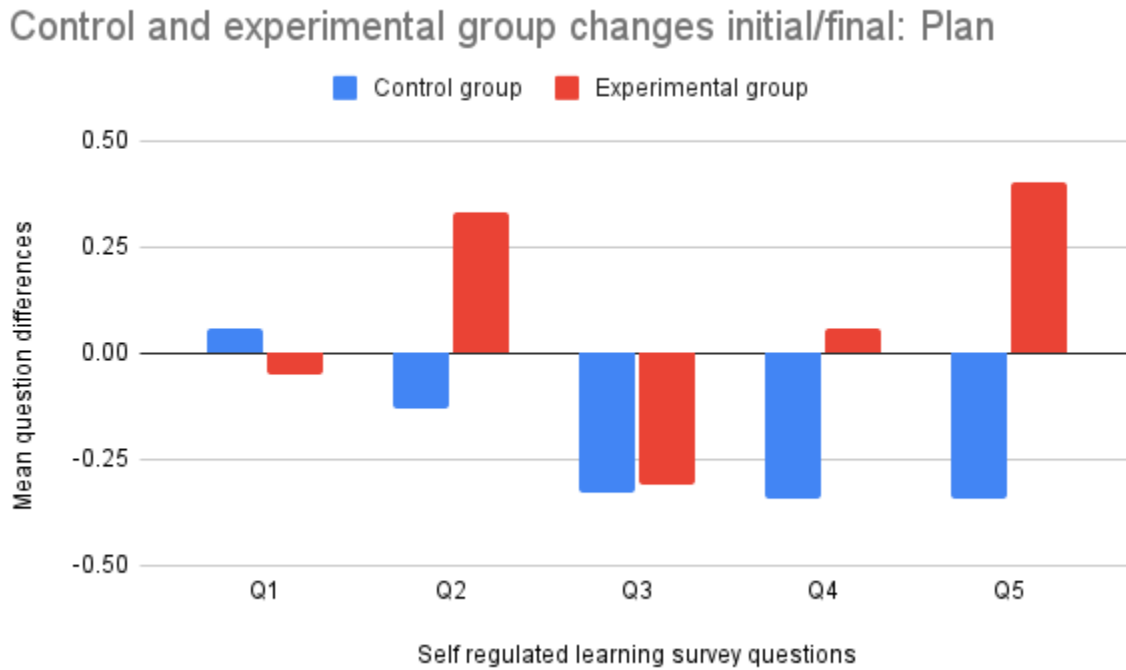
### **Self-Regulated Learning: Plan**

**Table 3**

*Survey Questions Related to Planning in Self-Regulated Learning*

<b>Survey Questions Related to Planning in Self-Regulated Learning</b>
Q1. I plan out projects that I want to complete.
Q2. If an important test is coming up, I create a study plan.
Q3. Before I do something fun, I consider all the things that I need to get done.
Q4. I can usually estimate how much time my homework will take to complete.
Q5. I have trouble making plans to help me reach my goals.

Table 3 presents the survey questions relating to the planning aspect of self-regulated learning theory. Students were asked to rate themselves on a Likert-type scale, 1 being “not very like me” and 5 being “very much like me.” The mean question differences between control and experimental groups are presented in Figure 2. The mean and standard deviation scores for each question are listed in Table 4.

**Figure 2***Mean question differences in control and experimental groups: Plan***Table 4***Control and Experimental Group Changes Initial/Final: Plan*

Question	Control Group				Experimental Group				
	Initial survey		Final survey		Initial survey		Final survey		p-value
	M	SD	M	SD	M	SD	M	SD	
Q1. I plan out projects that I want to complete.	3.68	0.82	3.7	0.72	3.05	1.05	3	1.02	0.004
Q2. If an important test is coming up, I create a study plan.	2.43	1.45	2.53	1.29	2.17	1.01	2.5	1.24	0.57
Q3. Before I do something fun, I consider all the things that I need to get done.	3.43	0.96	3.53	1.35	3.58	0.93	3.27	1.07	0.59
Q4. I can usually estimate how much time my homework will take to complete.	3.81	0.67	3.93	1.06	4.05	0.89	4.11	0.9	0.81
Q5. I have trouble making plans to help me reach my goals.	3.12	0.74	3.13	1.16	3.17	1.07	3.22	1.16	0.50

Table 4 shows the calculated mean and standard deviation of the survey responses for the questions relating to planning in self-regulated learning. The initial survey means ranged from 2.43 to 3.81 for the control group and from 2.17 to 4.05 in the experimental group. The standard deviation ranged from 0.67 to 1.45 in the control group and from 0.89 to 1.07 in the experimental group. This shows that the range of responses in the control group was larger than the range of responses in the experimental group. On the final survey, the means in the control group survey ranged from 2.53 to 3.93 while the experimental group means ranged from 2.5 to 4.11. Standard deviations in the control group ranged from 0.72 to 1.35 and in the experimental group, the range was 0.9 to 1.24. Again, the control group showed the greatest variety of responses to survey questions. The p-values calculated in the two-sample t-test suggest no statistical significance except for the first survey question with a p-value of 0.004.

#### **Self-Regulated Learning: Monitor**

Table 5 presents the survey questions relating to the monitoring aspect of self-regulated learning theory. Students were asked to rate themselves on a Likert-type scale, 1 being “not very like me” and 5 being “very much like me.” The mean question differences between control and experimental groups are presented in Figure 3. The mean and standard deviation scores for each question are listed in Table 6.

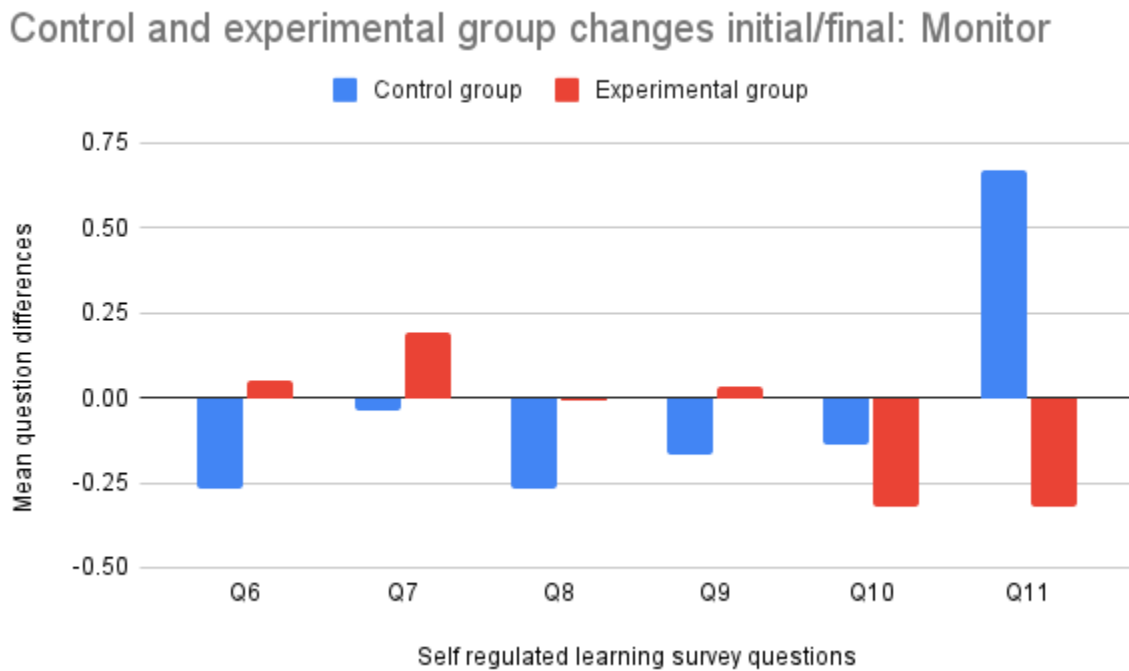
**Table 5**

*Survey Questions Related to Monitoring in Self-Regulated Learning*

<b>Survey Questions Related to Monitoring in Self-Regulated Learning</b>
Q6. I keep track of how my projects are going.
Q7. I know when I'm behind on a project.
Q8. I track my progress to reach my goal.
Q9. I know what my grades are at any given time.
Q10. I daily identify things I need to get done and track what gets done.
Q11. I have trouble remembering all the things I need to accomplish.

**Figure 3**

*Mean question differences in control and experimental groups: Monitor*



**Table 6***Control and Experimental Group Changes Initial/Final: Monitor*

Question  Likert Scale from 1 (not very much like me) to 5 (very much like me)	Control Group				Experimental Group				
	Initial survey		Final survey		Initial survey		Final survey		P-value
	M	SD	M	SD	M	SD	M	SD	
Q6. I keep track of how my projects are going.	3.53	0.91	3.26	1.27	3.17	1.01	3.22	0.8	0.50
Q7. I know when I'm behind on a project.	4.5	0.63	4.46	0.51	4.47	1	4.66	0.59	0.37
Q8. I track my progress to reach my goal.	3	1.46	2.73	0.96	3.06	1.08	3.05	0.87	0.53
Q9. I know what my grades are at any given time.	4.3	0.97	4.13	1.12	3.97	1.02	4	0.9	0.39
Q10. I daily identify things I need to get done and track what gets done.	3.6	1.12	3.46	0.99	3.76	1.2	3.44	1.09	0.21
Q11. I have trouble remembering all the things I need to accomplish.	3.33	1.17	4	1	3.65	1.27	3.33	1.18	0.74

Table 6 shows the calculated mean and standard deviation of survey responses for the questions related to monitoring in self-regulated learning. The initial survey means in the control group ranged from 3 to 4.5 and in the experimental group the range was from 3.06 to 3.97. The standard deviation in the control group's initial survey responses ranged from 0.63 to 1.45 and the experimental group's range was from 1 to 1.27. The control group showed a larger range of responses on the initial survey than the experimental group. In the final survey, the mean question responses in the control group ranged from 2.73 to 4.46 and the experimental group showed a range from 3.22 to 4.66. The standard deviation in the control group ranged from 0.51 to 1.27 and the experimental group showed a range of 0.59 to 1.18; a comparable range of responses was demonstrated in both groups. The p-values calculated from the two-sample t-test reveal no statistical significance. A change in means between the groups of 0.99 on the question,

“I have trouble remembering all the things I need to accomplish” indicates that the control group was in general feeling busy and potentially overwhelmed at the time of the final survey.

### **Self-Regulated Learning: Adjust**

Table 7 presents the survey questions relating to the adjusting aspect of self-regulated learning theory. Students were asked to rate themselves on a Likert-type scale, 1 being “not very like me” and 5 being “very much like me.” The mean question differences between control and experimental groups are presented in Figure 4. The mean and standard deviation scores for each question are listed in Table 8.

**Table 7**

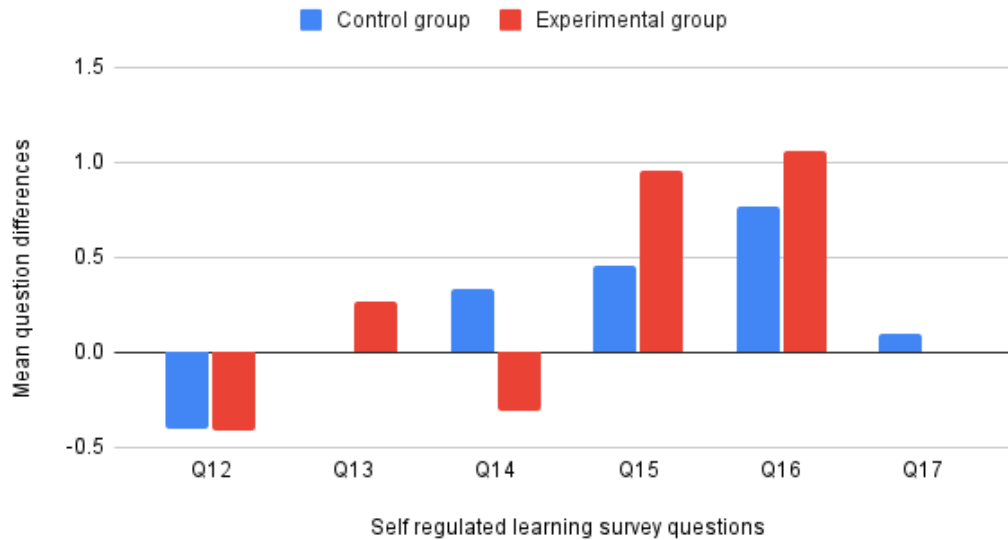
*Survey Questions Related to Adjusting in Self-Regulated Learning*

<i>Survey Questions Related to Adjusting in Self-Regulated Learning</i>
Q12. I do what it takes to get my homework done on time.
Q13. I make choices to help me succeed, even when they aren't the most fun right now.
Q14. As soon as I see things aren't going right, I want to do something about it.
Q15. I keep trying as many different possibilities as necessary to succeed.
Q16. I have difficulty maintaining my focus on projects that take a long time to complete.
Q17. When I get behind on my work, I often give up.

**Figure 4**

*Mean question differences in control and experimental groups: Adjust*

Control and experimental group changes initial/final: Adjust



**Table 8**

*Control and Experimental Group Changes Initial/Final: Adjust*

Question  Likert Scale from 1 (not very much like me) to 5 (very much like me)	Control Group				Experimental Group				
	Initial survey		Final survey		Initial survey		Final survey		P-value
	M	SD	M	SD	M	SD	M	SD	
Q12. I do what it takes to get my homework done on time.	3.8	0.99	3.4	0.91	3.76	0.66	3.35	1.06	0.88
Q13. I make choices to help me succeed, even when they aren't the most fun right now.	3.8	0.94	3.8	1.14	3.11	0.78	3.38	0.82	0.15
Q14. As soon as I see things aren't going right, I want to do something about it.	3.8	0.86	4.13	0.63	3.58	1.06	3.27	0.97	0.14
Q15. I keep trying as many different possibilities as necessary to succeed.	3	0.92	3.46	0.91	2.7	1.04	3.66	0.93	0.93
Q16. I have difficulty maintaining my focus on projects that take a long time to complete.	2.5	1.4	3.27	1.03	1.88	0.99	2.94	1.21	0.54
Q17. When I get behind on my work, I often give up.	3.9	1.09	4	1.19	4	1	4	0.9	0.5



Table 8 shows the calculated means and standard deviation of survey questions related to the adjust aspect of self-regulated learning. The control group means in the initial survey ranged from 2.5 to 3.8 and the experimental group ranged from 2.7 to 3.76. The standard deviation of initial survey responses in the control group ranged from 0.86 to 1.09 and the experimental group ranged from 0.66 to 1.06. The experimental group's initial survey responses were more varied than the control group. The control group final survey means ranged from 3.27 to 4.13 and the experimental group means ranged from 2.94 to 4. The standard deviation range in the control group was 0.63 to 1.19 and the experimental group ranged from 0.82 to 1.21. The control group had a larger range of responses than the experimental group. The p-values from the two-sample t-test reveal no statistical significance.

### **Self-Regulated Learning: Reflect**

Table 9 shows the survey questions related to reflection in Self-Regulated Learning theory. Students were asked to rate themselves on a Likert-type scale, 1 being “not very like me” and 5 being “very much like me.” The mean question differences between control and experimental groups are presented in Figure 5. The mean and standard deviation scores for each question are listed in Table 10.

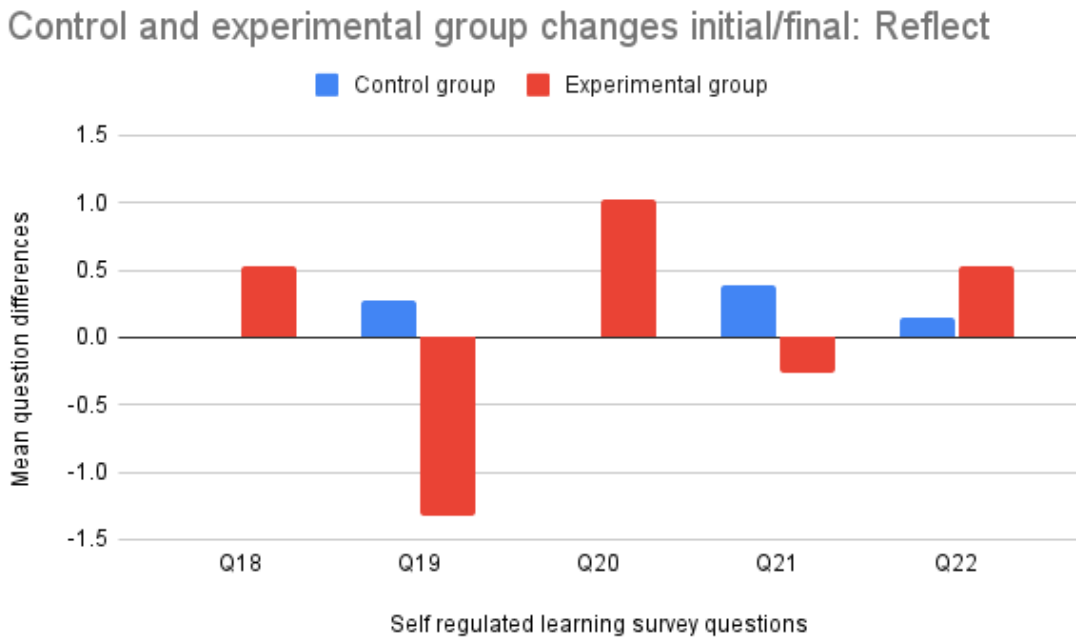
**Table 9**

*Survey Questions Related to Reflecting in Self-Regulated Learning*

<b>Survey Questions Related to Reflecting in Self-Regulated Learning</b>
Q18. I think about how well I'm doing on my assignments.
Q19. I feel a sense of accomplishment when I get everything done on time.
Q20. I think about how well I've done in the past when I set new goals.
Q21. When I fail at something, I try to learn from my mistakes.
Q22. I keep making the same mistakes over and over again.

**Figure 5**

*Mean question differences in control and experimental groups: Reflect*



**Table 10**

*Control and Experimental Group Changes Initial/Final: Reflect*

Question  Likert Scale from 1 (not very much like me) to 5 (very much like me)	Control Group				Experimental Group				
	Initial survey		Final survey		Initial survey		Final survey		P-value
	M	SD	M	SD	M	SD	M	SD	
Q18. I think about how well I'm doing on my assignments.	4.13	0.64	4.13	0.83	3.35	0.86	3.88	0.85	0.30
Q19. I feel a sense of accomplishment when I get everything done on time.	4.13	0.99	4.4	0.82	4.76	0.56	3.44	0.98	0.84
Q20. I think about how well I've done in the past when I set new goals.	3.25	1.4	3.26	1.03	3.47	1.12	4.5	0.89	0.39
Q21. When I fail at something, I try to learn from my mistakes.	4.01	0.88	4.4	0.51	3.53	0.62	3.27	0.82	0.09
Q22. I keep making the same mistakes over and over again.	3.46	0.91	3.6	0.98	3.41	0.93	3.94	0.8	0.68

Table 10 shows the calculated means and standard deviations for the questions on the Self-Regulation survey related to reflection. In the initial survey, the control group means ranged

from 3.25 to 4.13 and the experimental group ranged from 3.35 to 4.76. The standard deviation of initial survey responses in the control group ranged from 0.64 to 0.99 and the experimental group had a standard deviation range of 0.56 to 1.12. The experimental group showed a larger range of responses. The final survey means in the control group ranged from 3.26 to 4.4 and the experimental group ranged from 3.27 to 4.5. The standard deviation of these responses ranged from 0.51 to 1.03 in the control group and from 0.8 to 0.98 in the experimental group. The experimental group's responses were closer together, while the control group rated themselves within a larger range. The p-values calculated from the two-sample t-test reveal no statistical significance. Changes in the mean from initial survey to final survey that were significant include the question "I feel a sense of accomplishment when I get everything done on time," such that the experimental group decreased 1.59 points from the control group; "I think about how well I've done in the past when I set new goals," such that the experimental group increased 1.02 points from the control group; and "When I fail at something, I try to learn from my mistakes," such that the experimental group decreased 0.65 points from the control group.

The researcher also asked students survey questions to gain insights into aspects of their experience during the practice quizzes and the relationship to self-regulated learning. A 5-point Likert type scale was used (5=strongly agree, 1=strongly disagree). When asked if practice quizzes allowed students to gain insights into their understanding of course content, 89.5% of the experimental group participants responded with strongly agree or agree; 85.7% of the control group responded with strongly agree or agree. When asked if the practice quizzes helped them plan their study time outside of class, 31.6% of the experimental group strongly agreed or agreed, while 64.3% of control group participants agreed or strongly agreed. When asked if the practice quizzes offered them a new way to study, 84.2% of experimental group participants

agreed or strongly agreed, while 85.7% of control group participants agreed or strongly agreed. When it came to reflection, students were asked if the practice quizzes helped them reflect on their thinking. 79% of experimental group students agreed or strongly agreed and 78.6% of the control group agreed or strongly agreed. Table 11 summarizes these responses.

**Table 11**  
*Summary of post-study survey questions*

Question	Control group	Experimental group
5 point Likert scale from 1 (strongly disagree) to 5 (strongly agree)	(% of students who “agreed” or “strongly agreed”)	
The practice quizzes allowed me to gain insights into my understanding of course content.	85.7%	89.5%
The practice quizzes helped me plan my study time outside of class better.	64.3%	31.6%
The practice quizzes offered me a new way to study.	85.7%	84.2%
The practice quizzes allowed me to reflect on my learning.	78.6%	79%

## Discussion

### Overview of Study

The purpose of this study was to determine if reflection on retrieval practice quizzes had an effect on students’ ability to self-regulate their learning. This study was conducted with 33 students in 11th and 12th grades during an honors anatomy and physiology course. An initial self-regulated learning survey was administered to students and all students participated in retrieval practice quizzes during the eight-week study. One class section also received a reflection tool to use while taking the quizzes while one class did not utilize this tool. At the end of the eight-week intervention, all students were given the same self-regulated learning survey.

The survey results were compiled and analyzed to determine if there was any effect on self-regulation of learning with the use of the reflection tool.

### **Summary of Findings**

The survey was conducted prior to the start of the intervention and again conducted at the end of the study. Tables 1 and 2 show the initial and final survey scores as well as the difference in the scores. The differences ranged from -13 to 19 in both control and experimental groups. The mean change in the experimental group was 0.278 and the control group showed a mean change of 0.73 with p-values of 0.85 and 0.79, respectively. This indicates that the reflection tool did not have a significant effect on the self-regulation of these students.

The researcher also asked students in an anonymous survey what their experience and impressions were regarding the practice quizzes and use of the reflection tool in regards to self-regulation in their learning. One student said, "I appreciated the opportunity to evaluate myself. Having a non-graded quiz was helpful for me to learn more about where I need to improve without any stress. I appreciated it whenever we had a quiz, as it was good for me to see where I was compared to expectations." Another student commented, "I very much enjoy using the practice quizzes as a method of studying. They are a very important tool in my learning experience that show me my weak areas and highlight what gaps in my knowledge need to be filled." The reflection tool garnered mixed reactions. Seven students responded that the reflection tool prompted changes in their study habits over time, while nine students reported they did not see any change in their habits. When asked if they would recommend the continued use of the reflection tool, 13 out of 19 students responded that they would recommend its continued use while 6 students responded "no." There was an overwhelming positive response

to the practice quizzes and the value for monitoring learning and reflecting on it was consistently reported from students.

### **Recommendations**

This researcher recommends the continued use of retrieval practice in the classroom setting. Retrieval practice quizzes are a tool that can be utilized in a variety of settings to encourage students to monitor their learning, reflect on it, identify gaps, and plan study sessions that will help students achieve their goals. While not all students saw marked increases in the self-regulation survey results, some students did experience those increases and have gained valuable insights into the way they learn and study. These insights could have lasting effects as students venture out into the next stages of their education and continue to be life-long learners. Previous studies (Cogliano et al., 2021; Hudseman et al., 2013; Kenney & Bailey, 2021) suggested significant gains in student achievement and degrees of self-regulation with the use of reflection on retrieval practice at the university level. The research studies available for high school students was very limited, so continued research about the connection between retrieval practice and self-regulation in this age group is recommended.

Training and professional development about self-regulated learning is also recommended for teachers. Self-regulation can be taught and improved; the teacher can be a catalyst for such improvement. Teachers who recognize the value of self-regulation and its role in developing confident, successful learners are well-poised to teach their students skills that will encourage self-regulation.

### **Limitations**

While much care and thought went into the design of this study, the researcher recognizes there were factors that limited the study and the results. The study occurred within a small group

of students from one school population. A more diverse student population could have different results. These honors level students already exhibited relatively high levels of self-regulation. A small sample size, a lack of diversity, and relatively high starting levels of self-regulation could limit the impact of the reflection intervention and results of the study.

Behaviors are difficult to measure and even more difficult to change. The results of the study could be limited due to the nature of behavioral change. Students self-reported their levels of self-regulation in the survey at the beginning and conclusion of the study; this self-reporting could be influenced by the mood of the day or the current feeling of success they are experiencing on the day of the survey. Students may have had trouble connecting their experience of reflecting on practice quizzes to the survey questions, thus limiting the results of the final survey. The length of duration of the study also influenced the degree of change that could be observed. A longer intervention period could have resulted in changed habits resulting in changes to the self-regulatory behaviors of the students in the study.

### References

- Agarwal, P. (2020). Retrieval practice and Bloom's taxonomy: Do students need fact knowledge before higher order learning?. *Journal of Educational Psychology, 111*(2), 189-209.
- Ariel, R., & Karpicke, J. D. (2018). Improving self-regulated learning with a retrieval practice intervention. *Journal of Experimental Psychology: Applied, 24*(1), 43-56.
- Badali, S., Rawson, K. A., & Dunlosky, J. (2022). Do students effectively regulate their use of self-testing as a function of item difficulty? *Educational Psychology Review, 34*(3), 1651-1677. doi:<https://doi.org/10.1007/s10648-022-09665-6>
- Barenberg, J., & Dutke, S. (2019). Testing and metacognition: Retrieval practice effects on metacognitive monitoring in learning from text. *Memory, 27*(3), 269-279.
- Carpenter, S. K., Lund, T. J. S., Coffman, C. R., Armstrong, P. I., Lamm, M. H., & Reason, R. D. (2015). A classroom study on the relationship between student achievement and retrieval enhanced learning. *Educational Psychology Review, 28*, 353-375.
- Chen, X., Zhang, M., & Liu, X. (2019). Retrieval practice facilitates judgments of learning through multiple mechanisms: Simultaneous and independent contributions of retrieval confidence and retrieval fluency. *Frontiers in Psychology, 10*. doi:  
<https://doi.org/10.3389/fpsyg.2019.00987>
- Cogliano, M. C., Bernacki, M. L., & Kardash, C. A. (2021). A metacognitive retrieval practice intervention to improve undergraduates' monitoring and control processes and use of performance feedback for classroom learning. *Journal of Educational Psychology, 113*(7), 1421-1440.
- Gaumer Erickson, A. S., Monroe, K., Soukup, J., & Noonan, P. M. (2018). Self-regulation formative questionnaire. In P. Noonan & A. Gaumer Erickson. *The skills that matter:*



*Teaching interpersonal and intrapersonal competencies in any classroom* (p. 177-178).

Corwin.

Gjerde, V., Holst, B., & Kolstø, S. D. (2021). Integrating effective learning strategies in basic physics lectures: A thematic analysis. *Physical Review Physics Education Research*, 17(1). doi:<https://doi.org/10.1103/PhysRevPhysEducRes.17.010124>

Hudesman, J., Crosby, S., Flugman, B., Issac, S., Everson, H., & Clay, D. B. (2013). Using formative assessment and metacognition to improve student achievement. *Journal of Developmental Education*, 37(1), 2. <https://eric.ed.gov/?id=EJ1067283>

Kenney, K. L., & Bailey, H. (2021). Low-stakes quizzes improve learning and reduce overconfidence in college students. *Journal of the Scholarship of Teaching and Learning*, 21(2), 79-92.

Lavi, R., Shwartz, G., & Dori, Y. J. (2019). Metacognition in chemistry education: A literature review. *Israel Journal of Chemistry*, 59, 583-597.

Littrel-Baez, M. K., Friend, A., Caccamise, D., & Okochi, C. (2015). Using retrieval practice and metacognitive skills to improve content learning. *Journal of Adolescent & Adult Literacy*, 58(8), 682-689.

McKenna, K., Pouska, B., Moraes, M., & Folkestad, J. E. (2019). Visual-form learning analytics: A tool for critical reflection and feedback. *Contemporary Educational Technology*, 10(3), 214-228.

NGSS Lead States. (2013). Next Generation Science Standards: For states, by states.

Washington, DC: The National Academies Press.

Nix, I. & Wyllie, A. (2011). Exploring design features to enhance computer-based assessment: Learners' views on using a confidence-indicator tool and computer-based feedback.

*British Journal of Educational Technology, 42*(2), 101-112.

Nwafor, C. E., Obodo, A. C., & Okafor, G. (2015). Effect of self regulated learning approach on junior secondary school students' achievement in basic science. *Journal of Education and Practice, 6*(5), 45-52.

Osterhage, J. L., Usher, E. L., Douin, T. A., & Bailey, W. M. (2019). Opportunities for self evaluation increase student calibration in an introductory biology course. *CBE-Life Sciences Education, 18*(16), 1-10.

Rivers, M. L. (2021). Metacognition about practice testing: A review of learner's beliefs, monitoring, and control of test-enhanced learning. *Educational Psychology Review, 33*, 823-862.

Tanner, K. D. (2012). Promoting student metacognition. *CBE-Life Sciences Education, 11*, 113-120.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3-17.

## Appendix A

### Self-Regulated Learning Survey

Each item is rated on a Likert-type scale from 1 (not very like me) to 5 (very like me). Items that are framed negatively, and therefore reverse scored, are designated with “(N)”.

1. I plan out projects that I want to complete.
2. If an important test is coming up, I create a study plan.
3. Before I do something fun, I consider all the things that I need to get done.
4. I can usually estimate how much time my homework will take to complete.
5. I have trouble making plans to help me reach my goals.
6. I keep track of how my projects are going.
7. I know when I'm behind on a project.
8. I track my progress to reach my goal.
9. I know what my grades are at any given time.
10. I daily identify things I need to get done and track what gets done.
11. I have trouble remembering all the things I need to accomplish. (N)
12. I do what it takes to get my homework done on time.
13. I make choices to help me succeed, even when they aren't the most fun right now.
14. As soon as I see things aren't going right, I want to do something about it.
15. I keep trying as many different possibilities as necessary to succeed.
16. I have difficulty maintaining my focus on projects that take a long time to complete. (N)
17. When I get behind on my work, I often give up. (N)
18. I think about how well I'm doing on my assignments.
19. I feel a sense of accomplishment when I get everything done on time.

20. I think about how well I've done in the past when I set new goals.

21. When I fail at something, I try to learn from my mistakes.

22. I keep making the same mistakes over and over again. (N)

**Appendix B**

Post-Study Survey Questions

5 point Likert scale from 1 (strongly disagree) to 5 (strongly agree)

The practice quizzes allowed me to gain insights into my understanding of course content.

The practice quizzes helped me plan my study time outside of class better.

The practice quizzes offered me a new way to study.

The practice quizzes allowed me to reflect on my learning.

Appendix C

Practice Quiz Reflection Form

Name: \_\_\_\_\_

Learning Target:

Question #	Confidence	Feedback Notes to self	Correct Incorrect	Next steps Feed-forward
	High Medium Low		<input type="checkbox"/> ✓ <input type="checkbox"/> ✗	
	High Medium Low		<input type="checkbox"/> ✓ <input type="checkbox"/> ✗	
	High Medium Low		<input type="checkbox"/> ✓ <input type="checkbox"/> ✗	
	High Medium Low		<input type="checkbox"/> ✓ <input type="checkbox"/> ✗	
	High Medium Low		<input type="checkbox"/> ✓ <input type="checkbox"/> ✗	

What did you do to prepare for this practice quiz?

- Read text/re-read text/skim text
- Flash cards
- Retrieval practice (brain dump, etc.)
- Practice quiz
- Asked for help
- Highlight or underline text/notes
- Copy notes
- Study with a friend
- Other: \_\_\_\_\_
- Did not prepare

What insights did you gain about your understanding from this quiz?

How will you use this information to help you prepare for the unit test?

What tools or methods would you use to teach this topic to a friend?