



## Use of Self-Regulated Learning Strategies by Second-Year Industrial Engineering Students

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## Abstract

The Study Cycle is a set of guidelines rich with self-regulated learning (SRL) techniques that enables students to plan, prepare, and enact their studying by focusing on five comprehensive steps: previewing before class, engaging in class, reviewing after class, holding study sessions, and seeking help as a supplement. This paper reports on initial findings of a qualitative study in which a workshop on the Study Cycle was taught to a class of second-year Industrial Engineering students as an intervention, aiming to understand effects of the module on engineering students' SRL strategy use in an engineering course. Students self-reported SRL strategy use in a one-minute paper pre-workshop and two sets of post-workshop reflections. This paper examines which components of the Study Cycle students self-report as being useful in their engineering courses prior to the module and their perceptions of effective study strategies after the module. Main findings include that students self-reported SRL strategies from all ten categories which were analyzed via *a priori* coding: self-evaluation, organizing and transforming, goal-setting and planning, seeking information, keeping records and monitoring, environmental structuring, self-consequences, rehearsing and memorizing, seeking social assistance, and reviewing records.

## Introduction

The term “sophomore slump” has been widely used in literature after being coined by Freedman in his 1956 paper detailing the four years of the undergraduate experience<sup>1</sup>, but only in the last fifteen years has the sophomore year been addressed in education research and publications<sup>2-4</sup>. Evidence suggests that the second year can have a major impact on students' academic success<sup>5</sup>. Additionally, the second year is crucial for retention of university students<sup>6</sup> and retention in the major<sup>7</sup>. Though the second year should be a time when students are getting involved in professional, social, and academic organizations, sophomores often feel less connected to campus due to the lack of programming specifically designed for them<sup>8</sup>. Sophomores have also been shown to be the least academically involved out of the four typical student levels (freshmen, sophomores, juniors, seniors)<sup>9</sup>. To promote student academic success, persistence, and learning, academic programming can be added during the second year<sup>10</sup>. Since the second year is often the first opportunity for students to enroll in major-specific courses<sup>11</sup>, this is a natural area for the focus of research on how to retain students in science and engineering.

In *Visible Solutions for Invisible Students: Helping Sophomore Succeed*, Gardner<sup>9</sup> states that second year students are less likely to be engaged in their own learning, a key piece of SRL. Studies have shown that SRL strategy use is positively correlated with academic performance<sup>12</sup>, as well as motivation, and these SRL strategies are teachable<sup>13</sup>. Lemons and Richmond<sup>14</sup> stated that programs designed to help sophomores should focus on mentoring, individual counseling, and special programming to provide support through the “sophomore slump.” One type of

special programming, an intervention, has been attempted to help students adopt SRL strategies<sup>15</sup>, and many of the techniques utilized to teach students these skills have shown to be successful<sup>15,16</sup>. Second year courses are typically content-heavy, warrant better study skills, and require increased study time, thus leading to greater stress from internal and external sources<sup>17</sup>. Though programs have been put into place to help retain freshmen engineering majors<sup>18,19</sup>, not many studies have focused on initiatives to help sophomore industrial engineering (IE) students. This project aims to understand effects of a SRL workshop/intervention, framed by the Study Cycle, on IE students' SRL strategy use in an IE course.

## **Self-regulated Learning**

At a symposium at the 1986 American Educational Research Association (AERA) annual meeting, a group of researchers agreed on a definition of SRL combining three aspects of cognitive and affective domains that help students achieve their academic goals: motivation, metacognition, and self-directed action<sup>20</sup>. Later, Zimmerman and Schunk coined the phrase “masters of their own learning” to describe students who practice SRL techniques<sup>21</sup>. Self-regulated learners are seen to have high motivation in terms of self-efficacy and intrinsic task attributions<sup>22</sup>. Metacognitive strategies used by self-regulated learners include planning, self-monitoring, goal setting and self-evaluating<sup>12,23</sup>. Cognitive (i.e. behavioral) strategies help students with “learning, remembering, and understanding”<sup>12,23</sup> and include rehearsing, seeking help from people or resources, structuring an effective learning environment, and organizing<sup>12,24,25</sup>.

Zimmerman and Martinez-Pons developed a structured interview protocol, the Self-Regulated Learning Interview Scale (SRLIS), to analyze SRL strategies, or “actions directed at acquiring information or skill that involved agency, purpose (goals), and instrumentality self-perceptions,” used by students<sup>12</sup>. The outcomes of this study determined a new framework with 14 documented SRL categories: self-evaluation, organizing and transforming, goal-setting and planning, seeking information, keeping records and monitoring, environmental structuring, self-consequences, rehearsing and memorizing, seeking social assistance (peers, teachers, adults), and reviewing records (notes, books, tests). This study included definitions and examples of all fourteen of the SRL categories<sup>12</sup>. In 1988, this framework was further validated by the analysis of teachers' observations<sup>23</sup>. This interview protocol asks for answers from students in hypothetical learning situations where other SRL surveys obtain “retrospective” self-reports<sup>26</sup>. This IE SRL research study utilizes the SRLIS framework as it was the most appropriate for the qualitative data.

Hattie et al.<sup>16</sup> showed that a multi-strategy program can have successful effects on student learning and are more generalizable than a single-strategy approach. While a single-strategy approach, such as focusing on a specific reading deficit<sup>15</sup>, seems to have the largest impact on students, a multi-strategy intervention with a strict focus and narrow scope that focuses on “teaching, modeling, and practicing”<sup>13</sup> can help students learn multiple strategies they can apply

to their learning<sup>27</sup>. Based on past literature, Schunk and Zimmerman<sup>13</sup> suggest that multi-strategy initiatives include all three foundations of SRL to promote the appropriate “skill” and “will”: motivation, cognition, and metacognition. Thus, the intervention utilized in this research includes a variety of SRL techniques framed by the Study Cycle.

### **The Study Cycle**

The “Study Cycle,” adapted from the “Learning Cycle” created by Frank Christ<sup>28</sup> and outlined in Appendix A, is a set of guidelines for students rich with SRL techniques that enables students to plan, prepare, and enact their studying by focusing on four comprehensive steps: previewing before class, engaging in class, reviewing after class, and holding “intense” study sessions. Supplement has been added as a piece of the study cycle as seeking help is a key SRL process of successful students<sup>12</sup>. Key pieces of self-regulation included in the updated study cycle are goal setting, planning, monitoring, evaluating, and help seeking.

Teaching the Study Cycle during a class period has shown to reinforce aspects of metacognition and to correlate with increased academic performance in students in a general chemistry course<sup>29</sup>. While performance in first-year, general education courses is vital for engineering students to move through the curriculum, the transition of undergraduate engineering majors into the rigorous coursework in the engineering departments is specifically of interest. This paper reports on initial findings of a study in which a module on the Study Cycle was taught to a class of second-year IE students. More details about the Study Cycle can be found in the Methods section of this paper, which outlines the workshop that was utilized as the intervention in this project.

### **Research Purpose**

As the first step in this project, this paper examines both the components of the Study Cycle students self-report as being useful in their engineering courses prior to the module and their perceptions of effective study strategies after the module.

### **Methods**

Students in this study were enrolled in a sophomore-level IE class, Sophomore Seminar in Industrial Engineering, at a southeastern land-grant institution. This class, a required one -credit hour seminar offered in the fall semester of the sophomore year, is intended to orient students to the IE program. This course was chosen to introduce the module because it is the transitional course between other programs/departments and the IE major, and as such the content is both timely and relevant.

The majority of the students enrolled in the class are sophomores and juniors; the former have transferred from the first year engineering program and the latter typically have transferred from

other engineering majors. In fall 2014, the percentages of sophomores and juniors enrolled were roughly 50 and 35%, respectively (based on credit hours completed).

In Fall 2014, students in the Sophomore Seminar course attended a study skills workshop based on the Study Cycle a class assignment (N=81) as part of a qualitative study. Students were not included in the data pool if they did not complete any single portion of the intervention but were allowed to complete an alternative assignment; therefore, participants may be labeled a number greater than N. The number of students completing each assignment varied and is reported with the results in the next section. Students were given course credit for a one-minute paper, workshop attendance, one-week post-workshop reflection (Reflection 1), and end-of-semester reflection (Reflection 2). To improve the level of metacognitive reflection<sup>30</sup>, students were asked to identify a single course during all responses.

Prior to the workshop, students identified an IE course as the focus of their reflections. Additionally, each student wrote a one-minute paper responding to the prompt: “What strategies do you find successful that you use to study for this particular course? Why?”

The intervention was a one hour and fifteen minute workshop based on the Study Cycle which introduced a sundry of SRL techniques nestled into the Study Cycle framework: preview, engage, review, study, and supplement. The supplement section included additional self-regulatory strategies specific to the institution, such as seeking help from campus resources. The students were given a handout (see Fig. 1 in Appendix A) to reference during and after the presentation. More details about the intervention can also be found in Appendix B.

One week after the workshop, students submitted a reflection on strategies they will use in the course they identified in their original one-minute paper. After stating if they had previously seen strategies outlined in the workshop students were asked for a 500-word reflection on the following:

- How do you think your study habits will change, if at all, from the strategies you utilize that you discussed in the one-minute paper?
- Based on the presentation you attended, set personal goals of strategies to try when studying for the class you identified in the one-minute paper.

At the end of the semester, the students were asked to write a second 500-word reflection about strategies they had utilized in their specified course since the workshop. The following prompts were used:

- Did you change your study strategies after attending the workshop? If so, how, and if not, why not?
- Recall that you set personal goals of strategies to try when studying for this class. Which of the strategies (that you set as goals), if any, did you use? How did you benefit from them, if at all (if you didn't use any of these strategies, then write n/a)?
- Did you utilize any strategies that you did not include as goals? What were they (if you didn't use any such strategies, then write n/a)? How did you benefit from them, if at all (if you didn't use any such strategies, then write n/a)?

The one-minute papers, Reflection 1, and Reflection 2 were all given several read-throughs and then coded qualitatively. First, *a priori* coding was used to identify phrases in the responses that aligned with categories adapted from the 14 SRL subscales<sup>12</sup>; ten categories resulted from collapsing codes: “reviewing records” formed from “reviewing tests,” “reviewing textbooks,” and “reviewing notes” and “seeking social assistance” formed from “seeking social assistance from peers,” “seeking social assistance from teachers,” and “seeking social assistance from adults.” The final two categories have been collapsed because the differentiation between which social group or which type of record reviewed is of little interest in this study. Additional themes were allowed to emerge from the data. Phrases were highlighted as codes in RQDA, a qualitative data analysis package in the statistical software R. Because one-minute papers and reflections were self-reported by undergraduate students, only ideas that indicated some level of specific reflection were coded. For example for Reflection 1, the importance of the data was the goal-setting; therefore, “...if a homework problem is giving me difficulty, I like to be able to recognize that I am able to come back to the problem after sleeping on it, and I can usually get the problem right after doing that...” (Participant 15, Reflection 1) was not coded as the participant did not state a specific goal. The same student later set a very direct goal, which was coded as completing homework: “As a personal goal and strategy for my IE 2800 class then, I will set the goal and strategy of completing all the homeworks in a timely manner.”

### **Reliability and Validity**

Walther, Sochacka, and Kellam<sup>31</sup> established a quality assurance framework, Q<sup>3</sup>, looking to examine the validity and reliability of qualitative research: theoretical, procedural, communicative, and pragmatic validation, and process reliability. To satisfy the *theoretical validity* portion of this framework, SRL has been utilized as the context of this research, specifically following the work of Zimmerman & Martinez-Pons<sup>12</sup>. Additionally, experts in the field, such as Sandra McGuire, a former director in the learning center community, retired professor chemistry from Louisiana State University, and Science Education researcher, and colleagues from engineering education community were consulted in the research design to ensure *theoretical and procedural validity*. During the research design process, an IE undergraduate reviewed reflection questions to confirm the correct interpretation and to make sure IE undergraduates would understand how to complete the assignment, which lends to *communicative validity*. Representative quotes were selected from the one-minute papers and two sets of reflections as well. For *pragmatic validity*, students were asked to self-report on pre-existing strategies in a one-minute paper before the workshop and then to reflect on strategies that were utilized due to their attendance at the workshop. The one-minute paper serves as a baseline for the strategies learned through the SRL workshop. To ensure *process reliability*, attendance was taken to note the students who attended so that the legitimacy of post-reflections could be confirmed; field notes were taken by a trained colleague during the Study Cycle workshop to confirm student participation, and a debrief was held directly after the workshop. For further reliability, two researchers worked to consistently code all one-minute papers and reflections.

## Results and Discussion

Students were asked before the Study Cycle workshop to reflect on a specific course, preferably in IE. Several different courses were listed, including calculus and physics, but the sophomore and junior-level classes predominately selected were Methods of Operational Research I and Industrial Applications of Probability and Statistics I, respectively. These selections were not surprising, as both courses involve mathematics and modeling, have calculus courses as prerequisites, and are fairly rigorous. When asked about study strategies during the one-minute paper and both sets of reflections, students would talk about these strategies in the context of the course.

### *One-Minute Paper (Before workshop)*

Results of the one-minute paper analysis (N=77) show students identified seven of the ten categories before the workshop: goal setting and planning, information seeking, organization and transformation, rehearsing and memorizing, reviewing records, seeking social assistance, and self-evaluation.

Students self-identified several **goal setting and planning** strategies, including studying several days in advance of an exam, beginning homework early, and attending class. Additionally, several students mentioned keeping a calendar and other time management strategies. Students mentioned reading the book for a variety of reasons: to prepare for an exam, to prepare for class, to look up information to complete homework, or fill in their notes. Students mentioned applying methods from class to complete a homework assignment or lab experiment. This “use methods from class” code was placed into the **information seeking** category because the students are actively trying to find answers during lab or other instance and refer to notes/methods used in class. Other information sources used by students before the workshop include videos, note summaries, and other extra materials posted by professors on Blackboard, as well as solution manuals.

Students outlined **organization and transformation** techniques including: creating a note sheet, highlighting key ideas, taking notes about the readings, and working real-world example problems. Many **rehearsing and memorizing** techniques were elaborated including making flashcards, previewing before class, rereading the chapter, reworking homework and other problems, rewriting notes, and utilizing other memorization techniques. **Reviewing records** was frequently mentioned including review class materials, reviewing homework, reviewing materials for an exam, and reviewing pre-worked examples from class or the textbook. Over half of the students mentioned reviewing notes from lecture. A handful of students self-reported **seeking social assistance**, such as working with other students or attending office hours, but no students mentioned visiting with a tutor or advisor, asking for help from a friend or peer, or utilizing any campus resources. **Self-evaluation** techniques listed were limited, including taking

practice exams, checking homework solutions, and creating problems. Additionally, none of the students mentioned **self-monitoring**, **self-consequences**, or **environmental structures**.

While many strategies were mentioned by students, the majority were time management (**goal setting and planning**), memorizing techniques (**rehearsal and memorization**), or review of lecture materials (**reviewing records**), and often times the strategies were very vague: “I read the material assigned” (Participant 40, one-minute paper). Strategies from these three categories alone will not foster academic success or allow persistence in the IE major.

### *Reflection 1 (One Week Post-Workshop)*

Reflection 1 (N=68) was due one week after the students attended the Study Cycle workshop during class time, in which students set goals of study strategies to try based on the presentation. Many students listed multiple goals, and strategies from each of the ten categories were mentioned.

A handful of students set **Environmental structures** goals to alter life habits such as sleeping or eating in a healthier way and changing their study environment:

Distractions are a huge issue for me so I will try to go to a quiet place to study such as the lower floors of the library, try not to look at my phone for periods at a time, and make sure that I am not hungry when I am studying. (Participant 18, Reflection 1)

A small number of participants set **Self-consequences** goals to utilize a reward system:

I also am going to set up rewards for accomplishing assignments, or reading, as in, if I finish a goal, I will reward myself by watching my favorite tv show, or going running. (Participant 62, Reflection 1)

While many students listed some aspect of **Goal setting and planning** as a goal, some students specifically mentioned having never utilized any form of organizer or planner, while others felt able to renew their time management goals due to the workshop. One student described how “the studying [he had] been doing has already paid off in stress relief alone”:

If I can implement some of the study habits we discussed at the presentation like studying a little everyday as well as starting to study much a week in advance to major tests or exams than I will be in a much happier place. I wouldn't have to be trying my hardest to remember things I have no idea how to do and stressing myself out right before the test. ... I have a math exam next week and I have already started studying for it just like I had planned. (Participant 12, Reflection 1)

Many students mentioned goals of taking breaks while studying, coordinating a study plan, studying the hardest material first, or starting to study for an exam early.



Many students no longer referenced **Information seeking**, such as checking the posted videos to find answers or using methods from class. Instead, students set goals to fill in their notes. They often set goals to utilize the textbook or internet to figure out how to solve a problem or find information:

For now, I believe that I will put more emphasis on coming to classes already knowing the information to be covered. Basically, I would like to try to learn as much as I can from the book, online or from examples before even showing up in class. (Participant 30, Reflection 1)

The Study Cycle was adapted for this workshop to focus on transforming information during study sessions. Students set **Organization and transformation** goals to summarize material in their own words and mentioned classifying, highlighting, or writing down “key points” (Participant 62, Reflection 1) while reading or studying:

If I start writing summaries of my notes at the bottom of the page I will be more motivated to study because I will not feel as overwhelmed. (Participant 76, Reflection 1)

Many students mentioned utilizing a more organized note taking setup, creating diagrams, outlining notes and material, and summarizing to rearrange information for understanding to “cement” (Participant 73, Reflection 1) their understanding as goals.

While only a few students mentioned previewing before class and reviewing after class in the one-minute papers, many students were specific about **Rehearsing and memorizing** strategies they would use to prepare for class and to study after to “reduce the amount of time it takes... to complete homework and ... need to study prior to an exam” (Participant 11, Reflection 1). Preview strategies included reading or skimming the text book and attempting homework problems. Reviewing strategies included rewriting notes, working or reworking problems, and writing down important equations. Students also mentioned making flashcards and utilizing memorization techniques.

To prepare for future assignments or exams, students set **Reviewing records** goals of reading assignments, reviewing class materials, examples, homework, notes, etc. One new thing mentioned included discussing materials to review them.

After attending the Study Cycle workshop, students set **Seeking social assistance** goals to attend tutoring or other learning center programs and utilize campus resources, such as professors, advisors, teaching assistants, peers, and the Writing Center. Utilizing these types of resources on campus was not mentioned as a strategy pre-workshop, with the exception of one student who specified that he would look for help but did not mention where.

Students mentioned setting **Self-evaluation** goals of evaluating their performance on exams after receiving their scores back, specifically to analyze where they went wrong and learn how to

improve. They also hoped to track their progress while studying “to see if the strategies [being used are] helping... actually learn [the] material” (Participant 60, Reflection 1). Students also explained, in different ways, that they wished to ensure that they understand the material: by completing or reviewing extra problems, checking “mathematical steps” (Participant 64, Reflection 1), and creating their own problems.

The majority of students set **Self-monitoring** goals to engage more in class: better preparation for class, sitting in a less distracting spot, or changing how they listened in class (by getting rid of computers or cell phones). Many students mentioned the self-monitoring activity from the workshop and set goals to monitor their own attention during class and study times. Taking notes during lecture was mentioned as a way to keep attention during lecture, something that was mentioned, but less frequently, in the one-minute papers.

Overall, the participants set multiple goals in Reflection 1, but most were not “SMART.” Students set goals that crossed categories, such as Participant 62 who attended lectures and finished homework early to preserve time to seek help from the professor before the due date.

#### *Reflection 2 (End of semester)*

Students (N=72) reflected on all ten of the categories and gave specific examples of techniques they tried of each type. The final number of students who attended the intervention and completed the one-minute paper, Reflection 1, and Reflection 2 was 55. **Environmental structures** were described, such as avoiding distractions, changing life habits and their study environment. Students most often mentioned finding somewhere quieter, such as the library. Students revealed intentionally avoiding specific distractions:

I have been training my attention span by eliminating things that distract me like my cell phone, social media on my laptop, friends, and other forms of communication. After practicing these methods for the past month or so, I have developed a stronger attention span in class and during my study time. (Participant 46, Reflection 2)

A few students mentioned **Self-consequences**, specifically utilizing rewards such as a snack or watching television after studying, while more had set a reward system as a goal in Reflection 1.

Participants mentioned **Goal setting and planning**: attending more class days, reviewing material on a schedule, beginning to study for exams earlier than before (i.e. less cramming), beginning homework early, setting study goals, and taking breaks, sometimes with a specific time limit. Participants reflected on time management changes, such as scheduling study times throughout the week or specifically scheduling out a study session, as in this example:

After the workshop, I began to write very detailed study plans for myself. I allotted time to work on each assignment and scheduled breaks every now and again to break up the work. Not only did this prevent me from forgetting about any assignments, it helped me

manage my stress a lot better. Sitting in the library for hours doing work non-stop is miserable however, knowing that I have scheduled break times makes my study time more bearable. (Participant 64, Reflection 2)

For **Information seeking**, students wrote less about checking resources such as the book or internet and more about filling in their notes and referring to posts by the professor such as videos, PowerPoints, and other supplemental course materials. Additionally, participants reflected on their use of campus resources and mentioned specific examples, which were not mentioned in the one-minute papers or Reflection 1.

Participants reflected about the value of their experience utilizing **Organization and transformation** techniques: summarizing material, writing down summaries of readings, and creating summary sheets to help with studying. Many students began taking neater, more organized notes and spent time reorganizing notes after class and while studying. Participants also tried and altered the Cornell Note Taking method or made note of a method they utilized. Other techniques related to organization and transformation of materials were tried:

I have found myself organizing material into what I already know, the concepts that are easy for me, and the concepts that are hard for me. This allows me to pinpoint difficult concepts, and allocate more studying time for topics that will take more time to teach myself. This allows me to feel more comfortable with the material, and it makes my study time more effective. (Participant 21, Reflection 2)

A large number of participants mentioned **Rehearsing and memorizing** including utilizing a preview and/or review technique to rehearse the material, especially reviewing the previous days notes just before class. Preview and review, as taught in the Study Cycle, were utilized by students to review records before and after class such that they will have seen the material multiple times and remember it better. Students who spoke about reworking problems had not mentioned this as a strategy before the workshop:

After the seminar, I did find that practicing more increased my confidence in answering questions. Instead of doing the bare minimum I decided to always do two or three more problems. This gave me more familiarity with certain types of questions and made me more confident with my answers when solving problems. (Participant 78, Reflection 2)

Students did not reflect on working problems from the book, online, etc. but spent more time referencing rewriting their notes and reworking problems shown in class.

For **Reviewing records**, a large number of participants mentioned using reviewing the previous days notes just before class, which is dual coded in **rehearsing and memorizing**. This type of review is used by students to not only rehearse the material but also to prepare them for class. Overall, participants mentioned reviewing more often, such as every day or multiple times during the week. They mentioned reviewing notes from the professor and other class materials.

I changed the fact that I would come into the lectures essentially “blind” to the topics we would cover that day in class. I benefitted in that I was not as stressed in class and felt like I had an advantage at the beginning of class because I already knew what was coming. It was like playing defense but you already knew what the other team was going to do on offense. This made it easier to combat the tougher concepts and learn more in class because I would not get discouraged when there was something that I did not understand initially. (Participant 5, Reflection 2)

Participants reflected on **Seeking social assistance** and specifically mentioned working in groups to study and review material with peers. They also utilized peers to assist in answering questions and fill-in their notes. Students attended tutoring and used other campus personnel as resources, asked more questions during and after lectures, and mentioned attending office hours, sometimes for the first time ever. Participants also mentioned making notes of questions during lecture to ask the professor or TA directly after class.

In Reflection 2, students more commonly **self-evaluated** their progress in a class, how well they were studying, and how well they were reaching their study goals:

First, I spend a few minutes planning and setting goals outlining what I would like to accomplish... I then reflect on what I have already learned and analyze my progress towards the goals I have set for myself. I then continue studying until I am confident that my goals have been met. (Participant 79, Reflection 2)

One of the categories with the largest change between the one-minute papers, Reflection 1 and Reflection 2 was **self-monitoring**. Some students set monitoring their attention as a goal but this was most frequently mentioned in Reflection 2 as a strategy that was successfully used during the semester. Students asked questions during class, purposefully paid extra attention, rid themselves of distractions, and sat in areas of the classroom and engaged in activities, such as note taking, to pay more attention during class.

All codes and categories for the one-minute paper, Reflection 1, and Reflection 2 sets are reported in Table 1 in Appendix C. Though students reflected many changes in study strategies, one limitation of this study is that all data was self-reported by the participants. Additionally, the one-minute paper, Reflection 1, and Reflection 2 were all required assignments, and students were penalized for not completing any of the responses. Though the overall outcome of the intervention appears positive, the qualitative analysis has of self-reported data may have been biased by the researcher’s background in learning support.

Students self-reported positive changes in attitude and academic performance after utilizing strategies from the Study Cycle. Participants mentioned increased exam and final grades, greater knowledge retention, decreased study time necessary to prepare for exams, greater confidence in their knowledge of the material, and less stress while studying and around exam time. Students

also revealed that they had not been studying enough before the workshop and that they were able to enjoy college life more after regulating their study habits.

## Conclusions

Overall, participants utilized less of the Study Cycle tools than they set as goals, which was to be expected. Students reported utilization of many new SRL strategies after the intervention; the main items that were tried successfully were previewing before class, reviewing course materials, working with peers to get questions answered, and transforming and organizing notes and other course materials. Students also utilized planning and goal setting strategies, along with time management techniques such as planning study sessions, all specified in the workshop. Utilizing the Study Cycle as a framework for SRL techniques appears to be beneficial as students can easily grasp and use the examples detailed.

## Implications for Practice

Based on results from student reflections, certain aspects of the Study Cycle workshop could be altered to more clearly and succinctly convey SRL strategies. First, the workshop should be shortened to an hour to keep students' attention; a break in the middle or more frequent activities (such as more frequent self-monitoring check-in's) would yield more student engagement. The presentation should focus less on note taking strategies and more on ways to transform information, with supplemental readings attached. The addition of the "supplement" part of the Study Cycle appeared to be extremely valuable as students self-reported use of campus resources, peers, TA's, and professors as a result of this section and could use more time.

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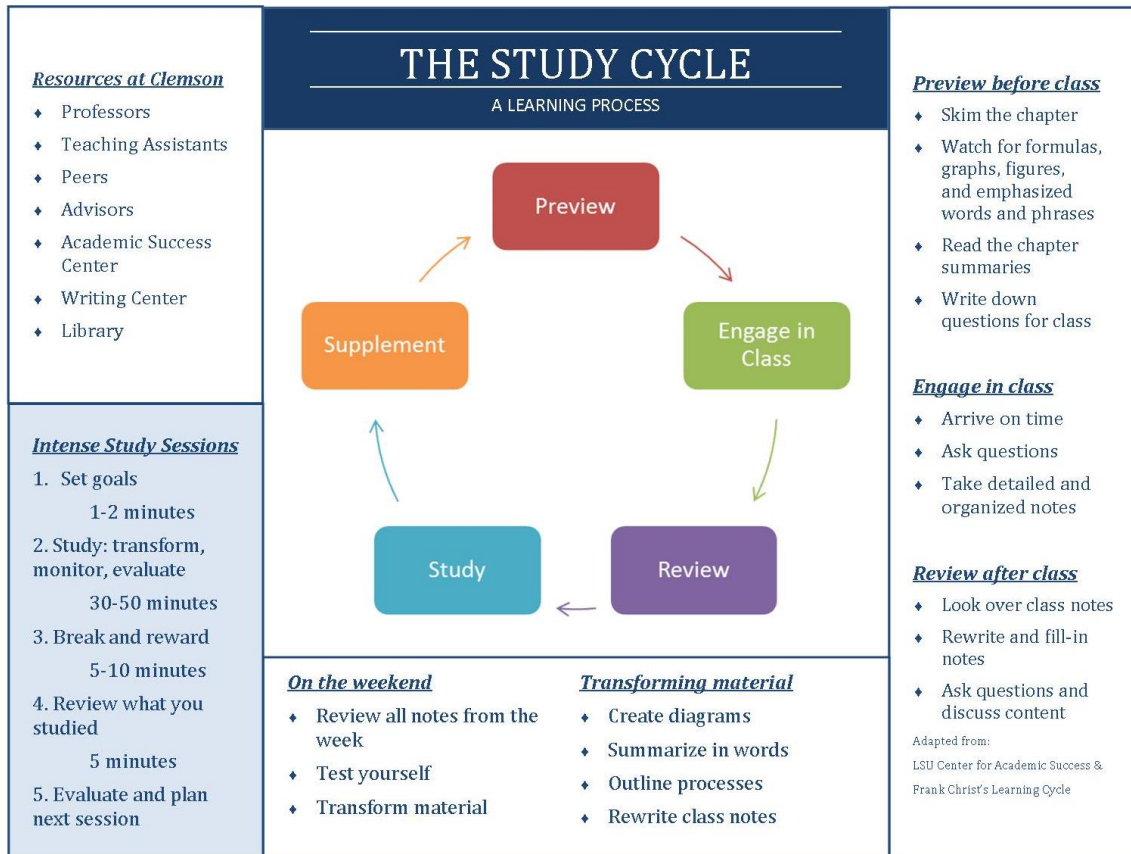
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## Appendices

### Appendix A: The Study Cycle, adapted from the “Learning Cycle”<sup>28</sup>



**Figure 1:** The Study Cycle Handout given to students during the intervention in the Industrial Engineering course during Fall 2014.

### Appendix B: Detailed description of the intervention (instructional module based on the Study Cycle)

At the beginning of the Study Cycle workshop, students were questioned about current study issues, such as finding strategies to study more efficiently. Bloom’s Taxonomy<sup>32</sup> was mentioned to provide the students with a framework as to the level studying required for first year courses versus second year, major courses. Throughout the presentation, students were asked to make note of their attention and anything distracting them during several “monitor your attention” slides.

The presentation stepped through the Study Cycle, starting with **Preview**. To reiterate the importance of repetition of material, athletics was utilized as an analogy through the presentation, with preview as the first “rep.” The students completed a reading activity to highlight the importance of previewing. Specific strategies were explained to the students that



can be used during previewing, such as scanning old notes, reviewing the syllabus, reading the chapter summaries, headings, and learning outcomes, and creating list of questions to be answered during class time.

During the **Engage** section, the presenter facilitated a two-part activity and discussion to stress the importance of being active, and not just listening, in class. Students sat back to back with the person facing the board as the direction-giver and the person facing the back of the classroom as the drawer. A picture was placed on the overhead and the direction-giver then explained to the drawer how to draw the picture while the drawer was only allowed to draw. The direction-giver then graded the drawer. A second picture was placed on the board and this time, the direction-giver and drawer were allowed to engage by asking and answering questions, pointing, and discussing, followed by another, often higher, grade. Both times, the drawer was not allowed to see the picture displayed on the board. A discussion about the difference between the two rounds was held in order to help students identify the second, more engaging turn as a successful classroom experience. After the discussion, students were taught about several different types of note taking, including the Cornell Note Taking method<sup>33</sup> and how to take notes on PowerPoints from the professor.

The **Review** section was initiated with a discussion of the “Curve of Forgetting”<sup>34,35</sup>. The discussion continued on the topics of editing, summarizing, reorganizing notes, writing questions, reflecting on notes and class discussions, and setting study plans during the review.

Goal setting and study time planning were discussed during the **Study** section, specifically mentioning “Intense Study Sessions” and “Weekend Review Sessions.” Students completed an activity by discussing SMART (Specific, Measurable, Attainable, Realistic, and Time Bound)<sup>36</sup> goals and then were tasked with writing their own. The group discussed pros and cons of different study locations and environments and then the presenter supplied an example of a well-developed “Intense Study Session”: a well-structured study plan that identifies timing and content for goals, plans, breaks, review, evaluate and adapt.

Several methods of monitoring, such as setting performance goals, and evaluating, such as utilizing a post-test analysis, while studying were presented. The benefits of self-monitoring<sup>37</sup> and self-evaluating<sup>38</sup> while studying were discussed. Specifics about how to transform material were analyzed and students were given examples such as concept mapping, summarizing information in their own words, and predicting test questions. A weekly review, showing students how to study for an exam, was detailed. To help the students connect with the resources that are available on campus, they were asked to list as many resources as they could remember with a partner. A discussion of class, learning center, and other campus resources was held for the **Supplement** section.

**Appendix C: Table 1. Categories and codes used in qualitative data analysis**

Category	Code
Environmental structures	<ul style="list-style-type: none"> <li>• Avoid distractions</li> <li>• Change life habits (eating, sleeping, etc.)</li> <li>• Change study environment</li> <li>• Find a quiet place to study</li> </ul>
Giving self-consequences	<ul style="list-style-type: none"> <li>• Use reward system</li> </ul>
Goal setting and planning	<ul style="list-style-type: none"> <li>• Attend class more regularly</li> <li>• Manage time</li> <li>• Pace</li> <li>• Plan studying/study sessions</li> <li>• Review every day or periodically</li> <li>• Review several days before exam/ahead of time</li> <li>• Set study goals</li> <li>• Start homework early</li> <li>• Study the hardest material first</li> <li>• Take study breaks</li> </ul>
Information seeking	<ul style="list-style-type: none"> <li>• Check class resources (book, internet, videos, etc.)</li> <li>• Fill in notes</li> <li>• Review the syllabus</li> <li>• Use campus resources (i.e. library, test banks, etc.)</li> <li>• Use example methods from class to solve problems</li> </ul>
Organization and transformation	<ul style="list-style-type: none"> <li>• Create note (summary) sheet</li> <li>• Write summaries of class materials</li> <li>• Highlight key ideas</li> <li>• Keep organized (neat, Cornell, PowerPoint) notes</li> <li>• Reorganize notes</li> <li>• Take notes about book or readings</li> <li>• Transform material</li> <li>• Work real world problems</li> </ul>
Rehearsing and memorizing	<ul style="list-style-type: none"> <li>• Attempt problems before class</li> <li>• Make flashcards</li> <li>• Preview before class</li> <li>• Read before class</li> <li>• Repetition</li> <li>• Reread the book</li> <li>• Rewrite notes</li> <li>• Rework course problems</li> <li>• Work problems (from book, online, etc.)</li> <li>• Skim the textbook</li> <li>• Use the “study cycle”</li> <li>• Utilize memorization techniques</li> <li>• Write down equations</li> </ul>

<p>Reviewing records</p>	<ul style="list-style-type: none"> <li>• Discuss lecture content</li> <li>• Read reading assignments</li> <li>• Review class materials</li> <li>• Review every day or periodically</li> <li>• Review examples</li> <li>• Review homework</li> <li>• Review materials for test</li> <li>• Review notes from professor</li> <li>• Review old notes just before class</li> <li>• Review same day</li> <li>• Review worked problems in book</li> </ul>
<p>Seeking social assistance</p>	<ul style="list-style-type: none"> <li>• Ask a tutor</li> <li>• Ask advisor</li> <li>• Ask Academic Success Center or other campus resources (person)</li> <li>• Ask for help</li> <li>• Ask other students</li> <li>• Ask TA</li> <li>• Ask teacher</li> <li>• Group work</li> </ul>
<p>Self-evaluation</p>	<ul style="list-style-type: none"> <li>• Create problems</li> <li>• Evaluate after exam</li> <li>• Evaluate studying</li> <li>• Make sure to understand</li> <li>• Review at end of study session</li> <li>• Self-test</li> </ul>
<p>Keeping records and monitoring</p>	<ul style="list-style-type: none"> <li>• Ask questions in class</li> <li>• Engage in class</li> <li>• Listen during lecture</li> <li>• Manage attention</li> <li>• Self-monitor</li> <li>• Sit in front/ center of the classroom</li> <li>• Take notes</li> <li>• Write questions down</li> </ul>