

Using Exam Wrappers in a Self-Directed First-Year Learning Strategies Course

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Abstract

This complete research paper focuses on the General Engineering Learning Community (GELC) at Clemson University, which provides academic support for first-year engineering students with insufficient calculus skills upon entry to the university. Students are cohorted in three primary STEM courses, math, chemistry, and engineering, as well as a two-credit hour learning strategies course that focuses on building skills around being an effective learner and STEM student. Entangled Learning was used as the pedagogical framework guiding the design of the learning strategies course, and the course aims to enhance students' self-regulatory behaviors, learning skills and strategies, and habits of mind. Among other assignments, student learning is assessed through a series of learning journal assignments, including an extensive set of exam wrapper activities, which will be the subject of this paper.

This paper will present a focused exploration of the exam wrapper activity results as they relate to academic achievement and increased metacognitive awareness for students within the program. The exam wrapper activity, which extends beyond traditional exam wrappers used in the context of undergraduate education, guides students in developing knowledge of their exam preparation, learning new preparation strategies, and engaging with those strategies in preparation for the next exam. The cycle continues as students analyze the results of their second exam to gain knowledge about the effectiveness of their new strategies. Prior to the first round of exams, students complete pre-exam assignments, including a week-long time tracking log and a reflection reporting perceived confidence level in each of the three cohorted courses. Following the first round of exams, students select the course in which they wish to improve their performance most significantly and then complete both an exam wrapper survey and learning strategies survey to evaluate their preparatory behaviors, conceptual understanding, and performance on the exam. Each student develops an action plan for improvement based on their results and begins implementation immediately. Following the second exam, students complete an exam wrapper survey followed by a learning journal, in which students evaluate and reflect on their adherence to and effectiveness of their action plan and performance on the second exam.

We propose that engagement with this exam wrapper activity in the context of the Entangled Learning framework contributes to students' knowledge of how to effectively learn in STEM courses in addition to sharpening metacognitive processes. A mixed methods approach will be utilized to analyze student learning gains by quantifying exam grades as well as qualitatively examining students' self-reported responses through reflections, exam wrapper survey results, and documentation of changed study behaviors.

Introduction

Our 2018 ASEE paper “Work in Progress: Strategic, Translational Retention Initiatives to Promote Engineering Success” [1] described a pilot program designed to leverage existing university resources to support successful course and program outcomes for first-year students entering general engineering with weak calculus skills. The General Engineering Learning Community (GELC) at Clemson University provides academic support for these first-year engineering students. One component of the program is a two credit-hour learning strategies course in the students’ first semester that focuses on building skills around becoming an effective learner and STEM student, with a special emphasis on developing competence in the students’ three core, cohorted courses: introductory engineering, general chemistry, and the first semester of an extended, year-long calculus course that includes review of precalculus concepts. The course is divided into three modules in order to enhance students’ self-regulatory behaviors, learning skills and strategies, and habits of mind. Student learning is assessed through a number of portfolio-based assignments, including a series of learning journals. The subject of this paper is a learning journal that focused on an exam wrapper activity within the course.

Entangled Learning

Entangled Learning [2], [3] provides the pedagogical framework for the learning strategies course. Entangled Learning is a process-oriented metacognitive model for individual and collective self-directed learning within a domain. The domain for our students is becoming effective STEM learners. The active processes of Entangled Learning, which include designing, learning, applying, and knowing, create an iterative cycle for developing as a learner.

Course activities and assignments are organized following the principles of Entangled Learning. The exam wrapper learning journal and its related exam wrapper activities align with an Entangled Learning approach by guiding students in developing knowledge of their exam preparation, learning new skills and strategies, and engaging with those strategies in preparation for the next exam. The cycle continues as students analyze the results of their preparation and performance on the second exam to gain knowledge of the effectiveness of their new strategies.

Exam Wrappers

Traditionally, exam wrappers are a tool used to scaffold student self-evaluation of their preparation and performance on graded assignments. Used most commonly in higher education, exam wrappers have gained popularity in STEM courses due to their ability to assist students in not only assessing, but also reflecting, on their learning and its tangible outcomes [4], [5], [6]. Additionally, exam wrappers have been shown to effectively promote metacognitive awareness [7]. Some collegiate courses that have been documented using exam wrappers include engineering mechanics [4], food science and human nutrition [5], introductory science [6], introductory calculus, statistics, and chemistry [7]. Previous research has also demonstrated that exam wrappers support undergraduate students in refining their study strategies [5].

Our goal in using the exam wrapper and surrounding activities was to help students develop enhanced metacognitive awareness and refine their learning and study strategies, while also

growing as learners. Metzger, Smith, Brown, and Soneral [6] describe their Student Metacognition, Affect, and Study Habits (SMASH) tool, a metacognitive inventory that goes beyond an exam wrapper. While this tool is designed to ultimately act as a form of summative assessment, our use of the exam wrapper activities was formative in nature and intended to support the students as they progressed through their courses. We believe that the exam wrapper activities used throughout our course, discussed in greater depth in the methods section, are more comprehensive than previous implementations of exam wrappers cited in existing literature.

Research Questions

Based on the goals of the learning strategies course and existing literature on exam wrappers in undergraduate STEM courses, we pose the following research questions:

1. What is the impact of using exam wrapper activities after the first round of exams on first-year engineering students' second exam scores?
2. How does engagement with the exam wrapper activity in the context of the Entangled Learning framework contribute to first-year engineering students' knowledge of how to effectively learn in STEM courses?
3. How does engagement with the exam wrapper activity sharpen first-year engineering students' metacognitive processes?

Methods

In the current study, a convergent mixed methods design will be utilized. This approach allows for a more complete understanding of the phenomena being studied, as the quantitative and qualitative results are used to corroborate one another [8].

Sample

The sample included students enrolled in each of the four sections of the learning strategies course linked with the GELC. For the quantitative sample, students in the GELC who took all six exams (CHEM 1 and 2, ENGR 1 and 2, MATH 1 and 2) and provided consent were included (n=80). Participants in the qualitative sample were students within the course who submitted the exam wrapper learning journal and gave consent for their work to be included in this research (n=78). Two students who took all six exams failed to submit an exam wrapper learning journal, therefore leading to the discrepancy between the quantitative and qualitative samples.

Data Collection and Procedure

One week prior to the first round of exams, students were prompted to reflect on their perceived confidence level in their understanding of the content and their preparation in each of the cohorted courses through a daily reflection. Additionally, students were instructed to track their time throughout the day in thirty-minute increments, taking note of study sessions, class sessions, meal times, and sleep, for the week leading up to the exams in the form of a time tracking learning journal (Appendix A). Following exams, students noted and described their most effective study session and evaluated their confidence levels.

Upon receiving exam scores, students completed an exam wrapper survey (Appendix B), which included learning outcomes from units covered on the exam and an evaluation of exam preparation behaviors for the STEM course in which they wanted to improve the most. In two of the sections of the course, in the following class session, students completed a learning strategies survey (the Study Behavior Survey adapted from Skillful Learning materials [9]) that asked students to identify behaviors that they practice within five categories.

Considering both the exam wrapper survey and the learning strategies survey, students created an action plan for improvement with at least two clear goals within the course chosen for the exam wrapper. These action plans were anonymously peer reviewed by two classmates and revised based on this feedback.

After receiving the score for the second exam in the chosen course, students completed the exam wrapper learning journal (Appendix C), providing documentation for engagement with their improvement plan, evaluating their adherence to the action plan and performance on the exam, and reflecting on their experience. For the purpose of this study, the exam wrapper learning journal responses were collected and analyzed.

Data Analysis

A series of comparative dependent, or paired, t-tests were conducted using IBM SPSS Statistics 25 to identify statistically significant changes between scores on the first exams and scores on the second exams. A dependent t-test was deemed appropriate as roughly the same participants were included at two time points throughout the semester. Each student's scores in the three STEM courses were added together to create a total exam one score and total exam two score, with the highest possible total score being 306, as extra credit points were available on the chemistry exams. While students focused efforts on one course for the exam wrapper activity, it is assumed that the effects of improved study behaviors influenced preparation in other courses. The mean for exam one scores and the mean for exam two scores were then compared to determine if a statistically significant difference existed between the exams at an alpha level of 0.01.

For the qualitative analysis, data from student responses on the exam wrapper learning journal were analyzed using thematic coding. Each submission of the exam wrapper learning journal was read in its entirety to identify emergent themes. As student responses were read, specific quotes that highlighted student experiences and aligned with emergent themes were gathered.

Results

Table 1 contains the descriptive statistics of scores for each of the six exams that the students in the GELC took as well as the totals of all exam one scores and the totals of all exam 2 scores.

TABLE 1
DESCRIPTIVE STATISTICS FOR EXAM SCORES

| EXAM | N | MINIMUM | MAXIMUM | MEAN | STD. DEV. |
|------|---|---------|---------|------|-----------|
|------|---|---------|---------|------|-----------|

| | | | | | |
|--------------|----|-------|-------|--------|-------|
| CHEM 1 | 80 | 0.0 | 102.0 | 74.83 | 17.47 |
| CHEM 2 | 80 | 32.0 | 104.0 | 69.95 | 15.88 |
| ENGR 1 | 80 | 21.0 | 95.5 | 72.09 | 16.83 |
| ENGR 2 | 80 | 10.0 | 100.0 | 75.54 | 18.38 |
| MATH 1 | 80 | 20.5 | 92.0 | 60.61 | 16.16 |
| MATH 2 | 80 | 28.0 | 95.0 | 69.30 | 17.09 |
| EXAM 1 Total | 80 | 101.0 | 270.0 | 207.52 | 40.10 |
| EXAM 2 Total | 80 | 86.5 | 292.5 | 214.79 | 41.34 |

Table 2 provides the outputs of the comparative statistical analysis that was run at an alpha level of 0.01 to determine if a statistically significant difference exists between exam 1 and exam 2 scores after engagement with a number of exam wrapper activities. The null hypothesis asserts that there is no difference between exam 1 and exam 2 scores. After running the t-test using IBM SPSS Statistics 25, our t-value, which estimates the difference between means, was 2.677 with 79 degrees of freedom. Additionally, the p-value (0.009), or level of significance, was determined to be less than the alpha level of 0.01, thus leading us to reject the null hypothesis and confirm that a statistically significant difference exists between exam 1 and exam 2 scores.

TABLE 2
DEPENDENT T-TEST OUTPUT

| | MEAN | STD. DEV. | t | df (n-1) | SIG. (2 TAILED) (p<0.01) |
|-----------------------------|--------|-----------|-------|-------------|-----------------------------|
| EXAM 2 Total - EXAM 1 Total | 7.2688 | 24.2837 | 2.677 | 79 | 0.009 |

In the qualitative analysis, the exam wrapper learning journal responses revealed four broad themes. Students expressed that engagement with the exam wrapper activities led to increased preparation for the second exam, enhanced confidence going into the exam, recognition of insufficient study practices, and increased understanding of oneself as a learner. Conversely, students who reported that they did not engage deeply with all of the exam wrapper activities stated feeling unprepared and unconfident going into the second round of exams.

Increased Preparation

Students who completed and engaged with all exam wrapper activities generally stated that they felt more prepared for the second round of exams. Many students discussed that setting goals held them accountable and encouraged preparation prior to the exam. For example, one student stated, “After striving to meet the goals I set, I found that they were helpful in preparing me for the exam.” Some students also gained an awareness of what is involved in sufficient exam

preparation, including both amount of time dedicated to preparing and type of studying activities. One student described their experience in the following way: “I believe I prepared 100 times better for this exam than any other class. I felt very comfortable while taking it. I studied for hours and did countless practice exams, so when it came time to take the exam it was like déjà vu.”

Enhanced Confidence

An additional emergent theme from the exam wrapper learning journals is that of enhanced confidence. Students who felt that they prepared adequately and engaged with the exam wrapper activities described feeling more confident going into their exams and having exam scores that matched their expectations. For example, one student discussed their experience in the following way: “Before I took my test, I felt fairly confident I would do well. I was positive I would do better than the first exam because I spent much more time studying for this exam. I felt like I understood almost all of the concepts that would appear on the test.” With test anxiety being a common impediment to success for students, incorporation of effective study strategies was found to lead to increased confidence as stress levels were reduced going into and during the exam. One student stated the following: “I felt a lot better going into the second exam. I had a clear head and felt like I had a good grasp of the knowledge. I was in a much better state of mind and a lot less stressed than [*sic*] when I went into the first exam.”

Recognition of Insufficient Study Practices

One of the results of completing exam wrapper activities was students’ identification of insufficient study practices. The exam wrapper helped students to “open [their] eyes to what [they are] doing right and wrong when preparing for an exam.” Students were encouraged to break down both their preparation for the exam and performance on the exam by analyzing why concepts were not understood and where questions were missed. Through this exercise, students realized the ways in which their studying was lacking and made appropriate changes or discussed ways to improve for the third round of exams. The following student response demonstrates this: “The way that I study needs to change as well. Most of my ‘studying’ is just reading over notes passively and not doing anything with them once I read them. I...must start working through more problems to familiarize myself with the methods of completing these math problems.”

Increased Understanding of Oneself as a Learner

The most significant and commonly discussed theme was that of students gaining a deeper understanding of who they are as learners. As a result of engaging in these activities, many students felt that they had pushed through a “wall” that had been blocking their success. They discovered the optimal duration of and methods for studying needed to learn the material. For example, one student revealed the following: “This [exam wrapper activity] helped me understand how I learn better. I realized that I need to do more practice based learning because that is where the real connections are made for me.” Another student commented that he “learned that short study times are much more effective for [his] learning and time efficiency.” Many students found that working in a team to learn collaboratively not only led to greater intellectual gains, but also helped students remain accountable and build social competence. One student

documented this sentiment in her learning journal: “I realize that I am now starting to learn faster in study groups. At first I had trouble with finding a group, but after the first test I found out [one of my classmates] was struggling and he agreed to us working together.”

What Was Learned by Students Who Didn't Fully Engage with the Exam Wrapper Activities?

For students who did not effectively follow their plan or complete the exam wrapper activities, growth as a learner still transpired, even in the absence of the desired results on the second round of exams. Students who prepared insufficiently often took responsibility for their lack of action. For example, one student expressed the following: “For my second exam I felt better going into it but still feel like I wasn't fully prepared to do well on any of them. I didn't follow my study plan because I hadn't gone to any [peer-led help] sessions or even been paying that great of attention in class. I would still sit on my phone knowing very well that if I don't pay attention I will not get a good grade on my exam.” Awareness and acceptance of one's place in their learning journey is an important first step in becoming a more effective student and learner. Students were candid about the reasons that they did not following through with their plans, and these obstacles most often included lack of prioritization or mismanagement of time, lack of motivation, and personal issues related to family, friends, or health.

Most students, regardless of their engagement level with the exam wrapper activities, discussed actionable steps for improvement going forward. For some students, these new goals were significant, such as beginning to study one week before an exam instead of the night before. For other students, the new goal involved refining current learning and study strategies, including attending more peer learning sessions or completing practice problems under timed test conditions. Regardless of the magnitude, students expressed a desire and plan for continued improvement.

Discussion

The quantitative results demonstrated that a statistically significant difference between first exam scores and second exam scores exists. This statistically significant difference in exam scores suggests that engagement with the exam wrapper activities may have enhanced student exam scores. However, it is also possible that other factors within and outside of the learning strategies course may have contributed to this increase in average exam scores. For example, targeted lectures and activities focused on specific learning resources and strategies may have influenced student performance. Additionally, students likely prepared more effectively for the second exam after seeing the format and style of questions on the first exam.

The qualitative results suggest that the exam wrapper activities positively contributed to first-year engineering students' knowledge of exam preparation behaviors, learning strategies, and awareness of metacognitive processes. Additionally, most students gained an increased sense of self as a learner as additional insights were uncovered through reflection on the exam wrapper learning journal. Taken together, the results of the quantitative and qualitative analyses suggest that the exam wrapper activities were effective in leading to improved scores on the second exam, enhanced understanding and utilization of effective learning strategies, and increased metacognitive awareness.

Limitations

One limitation of this study is that, through the quantitative analysis, we were not able to determine with absolute certainty that the exam wrapper activities were the only, or even the most substantial, factor contributing to students' increased utilization of effective learning strategies, metacognitive awareness, and exam scores. Since the students were enrolled in the learning strategies course, a number of activities within the course may have contributed to their learning and awareness gains. Students with higher motivation put more effort into the exam wrapper activities and into their overall study strategies for their courses. Correlational analyses must be conducted to better determine the relationship between engagement with exam wrapper activities and exam score gains.

An additional limitation is the lack of congruence across the sections of the learning strategies course. With four different instructors, there was inconsistency in the sections that were exposed to various activities related to the exam wrapper. Due to this, some students did not receive the complete intervention, though this was not accounted for in the current study and, instead, any engagement with the exam wrapper activities culminating in the exam wrapper learning journal was included as a part of the intervention.

Recommendations for Future Research

While initial results prove promising, additional research must be conducted to better understand the impact of exam wrapper activities. Future research should analyze the correlation between learning gains or increases in metacognitive awareness and improvement in exam scores. Further, quantifying engagement with the exam wrapper activities would allow researchers to analyze the relationship between level of engagement and the dependent variables discussed in this study. Additionally, a case study approach with maximum variation sampling could provide insight into the types of students who benefit the most from the exam wrapper activities.

Conclusion

Based on the results of the exam wrapper learning journal, the exam wrapper activities and delivery strategy were generally effective in increasing students' metacognitive awareness and ability to learn effectively in their current and future courses. This study suggests that use of an exam wrapper, especially for underprepared first-semester STEM students, likely increases their awareness of their study strategies and behaviors and aids students in developing a plan for continued improvement.

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Appendix A - Time Study Learning Journal Prompt

Purpose: The purpose of tracking your time is to raise your awareness of how much time you spend studying as well as your balance between studying and taking care of yourself.

Goals - What is your plan?

- Choose one of these articles to read:
 - “Manage Your Energy, Not Your Time”
 - [“I Tracked my Time in 15 minute Increments for a Week”](#)
- What action items from the article do you plan to practice during the next week?
- How many hours per day do you plan to study for each of your courses? (note: you should be studying or reviewing 2-3 hours for each hour in class)

Documentation - What did you do?

- Which article did you read?
- What actions did you actually take based on your plan and/or what adjustments did you make to your plan? Be specific - what, when, how, why
- Provide a link to your tracking sheet (Excel or PDF to print then scan) to document the following each day (consider using different colors for each of the activities listed below):
 - Sleep - time you fell asleep and woke up each day
 - When you ate meals
 - Classes and labs you attended
 - Study time
 - [PAL sessions](#), UTA hours, [MATHLab](#), or [tutoring](#) you attended
 - Individual or group study time (indicate course and amount of time)

Evaluation - What did you notice from doing it?

- How confident did you feel about your potential for success going into your ENGR 1020 and MATH 1040 exams?
- Describe your most effective study or review session:
 - What made this session so effective?
 - Where were you studying? What time of day was the session? For how long? Did you take any breaks during your study session?
 - What were you studying (subject and specific content)?
 - How did you study - what active learning techniques did you use?
 - How did you know that you had successfully learned the material?

Reflection - What is the meaning for you?

- How did this experience help you to better understand yourself as a learner? What did you take away from this experience?

Appendix B - Exam Wrapper Questions

Rate your understanding of the following objectives and then complete the questions about study strategies and test-taking skills that you used.

Learning Outcomes Analysis*

ENGR 1020 Exam 1 Module 2 Learning Outcomes

| | Great | Adequate | Insufficient | Nonexistent |
|---|-------|----------|--------------|-------------|
| Ch 7.1 Express quantities using correct SI prefixes | | | | |
| Ch 7.1 List the seven fundamental dimensions and their symbol | | | | |
| Ch 7.1 List the seven base SI units, their symbol, and the matching fundamental dimensions | | | | |
| Ch 7.1 Identify a quantity as a dimension or a unit | | | | |
| Ch 7.1 Express units correctly using the official SI rules | | | | |
| Ch 7.2 Recognize non-SI units acceptable for use with the SI system | | | | |
| Ch 7.2 Understand how to express dimensions in the three main unit systems (SI, AES, USCS) | | | | |
| Ch 7.3-7.5 Convert units within a fundamental dimension using the 5-step conversion procedure | | | | |
| Ch 7.3-7.5 Follow the 5-step conversion procedure when multiple steps are required | | | | |
| Ch 7.3-7.5 Apply the 5-step conversion procedure to any unit | | | | |

Study Strategies

How many hours did you spend preparing for the exam? (short answer response)

Estimate the number of hours you spent on each of the following in the week before the exam:

| | I did not spend any time doing this activity | 1-2 hours | 3-4 hours | 5-6 hours | 7-8 hours | 9-10 hours | More than 10 hours |
|---|--|-----------|-----------|-----------|-----------|------------|--------------------|
| working homework or example problems on your own | | | | | | | |
| working homework or example problems with help (friend, tutor, or PAL leader, office hours, etc.) | | | | | | | |
| reworking previously solved homework problems | | | | | | | |
| reworking examples from class discussion | | | | | | | |
| working extra problems from the textbook | | | | | | | |
| reading the textbook | | | | | | | |
| studying the material by reading or watching other supplemental materials | | | | | | | |

Which of the following behaviors did you engage in the day of the exam?

| | Did this | Did NOT do this |
|---|----------|-----------------|
| slept 8 or more hours the night before the exam | | |
| ate nutritious, balanced meals throughout the day of the exam | | |
| stopped studying at least 2 hours before the exam | | |
| did something to relax or calm myself before the exam | | |
| engaged in positive self-talk before and during the exam | | |

What was your greatest strength on this exam? (select one)

- Understood concepts
- Completed procedures
- Remembered formulas and definitions
- Successfully used algebra rules
- Managed time well
- Made some progress on every problem

Estimate the number of points you failed to earn due to each of the reasons below:

| | I did not miss any points for this reason | 1-5 points | 6-10 points | 11-15 points | 16-20 points | More than 20 points |
|--|---|------------|-------------|--------------|--------------|---------------------|
| misunderstood a concept | | | | | | |
| could not complete a procedure | | | | | | |
| forgot the formula or definition | | | | | | |
| made algebra mistakes | | | | | | |
| did not fully read the question | | | | | | |
| mismanaged time (went too quickly or ran out of time) | | | | | | |
| panicked and failed to get started on a problem | | | | | | |
| had correct thinking but recorded it in an incorrect way | | | | | | |

Name at least two exam prep behaviors you plan to change (or add) in order to do better on the next exam.

- _____
- _____

*The series of learning outcomes covered on the exam wrapper with rating scale of “great,” “adequate,” “insufficient,” and “nonexistent” varied by course and exam number.

Appendix C - Exam Wrapper Learning Journal Prompt

Purpose: The purpose of completing the exam wrapper is to become more aware of the connection between your preparation before the exam and the results so that you can improve your preparation for the next exam.

When you are preparing your answer, think about these questions. A great answer includes several sentences for each section.

Goals - What is your plan? (Do this first!!)

- Which class will you complete the exam wrapper for?
- What are the two exam prep behaviors that you plan to change (or add) in order to improve your performance on the next exam for that class?
- Write your improvement plan here.

Documentation - What did you do?

- Attach your improvement plan and create a link to your second exam wrapper results here.
- Based on the study plan that you created after the first exam, how well do you think you had prepared for the second exam?
- Did your second exam results match your expectations? Why or why not?

Evaluation - What did you notice from doing it?

- What are you doing well regarding your study habits?
- What could you do better?
- How can you improve in the future? What actionable steps will you begin taking (what - how - when)?

Reflection - What is the meaning for you?

- How did this activity help you to better understand yourself or the way that you learn?