Work in Progress: It's Not a Matter of Time!

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It's not a matter of time! (A work in progress)

Abstract

Wrappers are defined as a short form that students complete along with an assignment or exam that focuses on the learning process rather than on the content itself. In this study, students are asked to state the perceived "effort," the amount of time spent completing or studying for respective assessments and their preparedness to complete both formative and summative assignments in an Electrical Engineering (SCADA Systems and Design) and Mechanical Engineering (Dynamics) class. As expected, scores on formative assessments are mildly correlated with summative assessments. However, results indicate that time spent studying for summative assessments is not correlated to the summative assessment scores.

1   Introduction

Metacognition is an important aspect of one's learning. The ability to know how one learns can play a key role in the success of one's learning [1]. One method of asking students to reflect on their learning style and to the methods they use to learn, is to ask them to fill out a brief survey after an exam; generally, this is called a "wrapper". Some researchers do suggest that exam wrappers can, in a limited way, increase a student's performance [2], while others caution using them as a direct connection to a student's performance [3]. A more middle of the road interpretation may be that wrappers are useful in collecting information about students and building their confidence in knowledge of concepts and problem solving strategies [4]. Teaching students how to learn, and how they learn is important in their educational process. Previous work shows that this can be done [5].

The objective in this study is to investigate if students' perceived effort is correlated with student performance on formative and summative assessments. Our hypotheses are: H1) Student summative performance is negatively correlated with perceived effort and H2) Student summative perceived effort is negatively correlated with formative perceived effort.

Along with investigating how perceived effort correlates with performance, we found some other interesting results that will be discussed. We use the results of these wrappers to inform ourselves and the students as to how best they can learn and what habits may help or inhibit their learning. Wrappers are typically returned to students with graded summative assessments.

2   Methods

This is a collaborative study between faculty in the Electrical and Mechanical Engineering disciplines. Exam wrappers are selected to be implemented in two courses: Dynamics (25 students) and Supervisory Control And Data Acquisition (SCADA) Systems Design (10 students). These courses (referred to hereafter as Dynamics and SCADA) are selected as pilot courses because they are taught by the faculty at the time of this initial study. In addition, Dynamics is a heavily analytical course, compared to SCADA which is more qualitative – we thought this would yield some interesting results. Finally, note that there was only one student who overlapped into both classes.

2.1 Courses

Dynamics is a 3-credit hour lecture-based course. There are weekly homework assignments. These weekly assignments consist of 4 online homework problems and two hand written homework problems, assigned from the Hibbeler's *Engineering Mechanics: Dynamics* [6]. There are 3 exams during the course; two in-semester exams and 1 comprehensive final exam.

SCADA is also a 3-credit hour course with 2 hours of lecture and 3 hours of lab. The text used for the course is Bartlet's *Industrial Automation Systems* [7]. There are weekly in-class exercises and online quizzes. There are 4 exams during the semester and one comprehensive final exam, for a total of 5 exams.

2.2 Surveys

Formative and summative surveys were distributed with each summative assessment (exams). The formative survey was distributed prior to the summative assessment and the summative survey was distributed after the summative assessment. See Appendix A for the two surveys. Questions are included in the figure captions, for convenient reference. Ample time was given to complete the formative survey and the both surveys were generally returned with the exam. Students are informed to answer the formative survey questions reflecting on the formative assignments leading up to a summative assessment. For example, when filling out their second formative assessment students are asked to reflect on all homework leading up to Exam 2 from the previous exam. Formative scores include the average of all homework scores between summative assessments; whereas summative scores are simply the exam grades.

The data from all the surveys from each class was analyzed in MiniTab using the students' responses to the survey questions, formative scores, and summative scores. Boxplots, pie charts, and regression lines were developed to analyze the data.

3 Results

Data from the Dynamics class does not support the first hypothesis (Student summative performance is negatively correlated with perceived effort). In fact, the slope of the trend line is slightly positive ($R^2 = 0.006$). And although the trend observed in the SCADA class is such that a negative slope of a fitted line is observed, it still is not correlated ($R^2 = 0.292$). These results are shown in Figure 1, below.
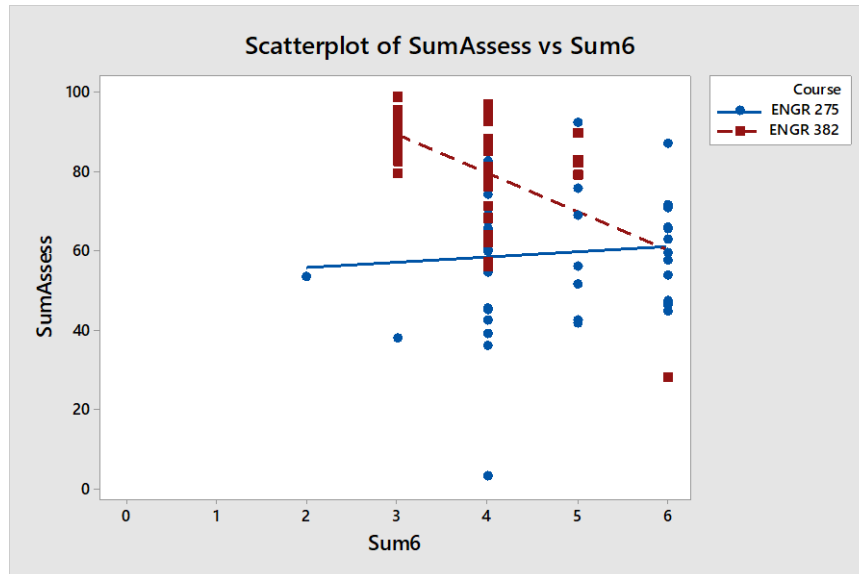
Figure 1: Summative assessment vs. Summative perceived effort
Summative assessments (exam scores) are not correlated with students perceived effort on exams.

Similar results (Figure 2) are observed when testing the second hypotheses: Student summative perceived effort is negatively correlated with formative perceived effort. Our data does not support the idea that as students put effort into completing their homework that the effort necessary to finish their exams will decrease – (practice makes perfect): $R^2 = 0.088$ for Dynamics and $R^2 = 0.008$ for SCADA.
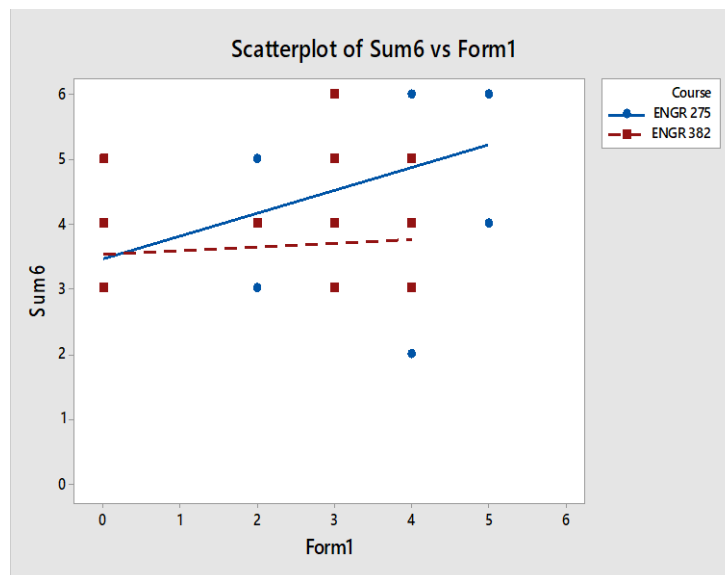
Figure 2: Summative perceived effort vs. Formative perceived effort
Efforts put forth by students to complete formative assessments did not correlate with summative assessments.

Digging deeper into the data, the first set of questions on the summative survey asks about time spent studying and about what students do to prepare for exams. Figure 3 contains the boxplot for summative survey responses to questions 1 through 4 for Dynamics and SCADA classes.
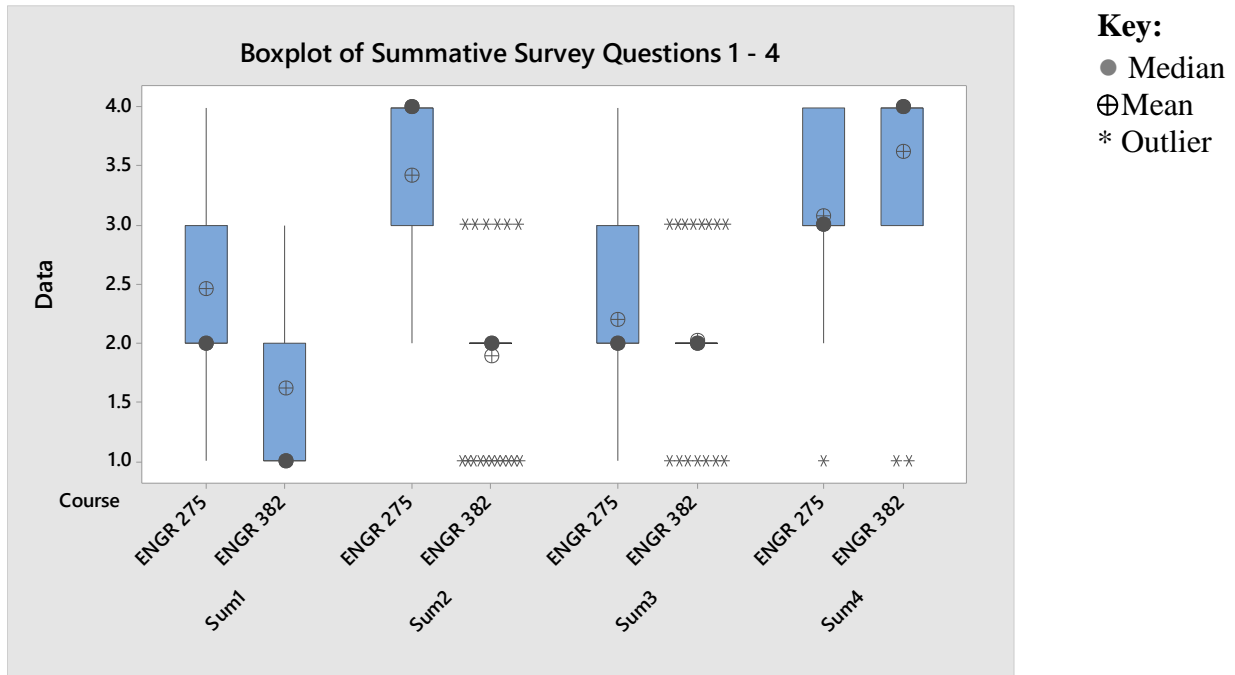
**Figure 3: Boxplot of Summative Survey Questions 1 to 4**

The summative questions are listed below for reader convenience. Also note ENGR 275 is Dynamics and ENGR 382 is SCADA.

| Sum1	How many hours did you spend studying for the exam? 1: Less than 3 hours, 2: 3 hours to 6 hours, 3: 6 hours to 9 hours, 4: More than 9 hours
Sum2	Did you work/answer all the homework problems? 1: None, 2: Some, 3: Most, 4: All
Sum3	How much of the required reading material did you read? 1: None, 2: Some, 3: Most, 4: All
Sum4	What percentage of what you read did you understand? 1: 0% to 24%, 2: 25% to 49%, 3: 50% to 74%, 4: 75% to 100%

This figure indicates students in Dynamics study longer and do homework more consistently than students in SCADA.

Question 5 of the summative survey asks about students' strategies for collaborative learning in preparation for exams. This question has the intent of suggesting to students that there are
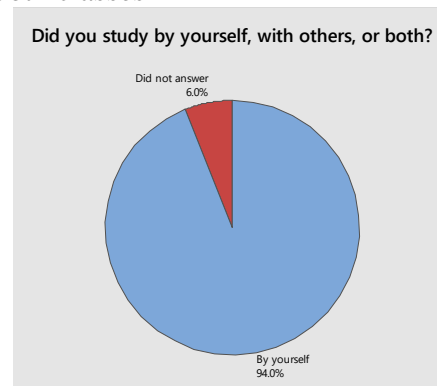
different strategies that could be used to studying: in groups, by themselves, or with some sort of mix. Surprisingly, while there is a good mix of studying strategy in Dynamics, *all* students from SCADA reported that they study alone (or they did not respond).
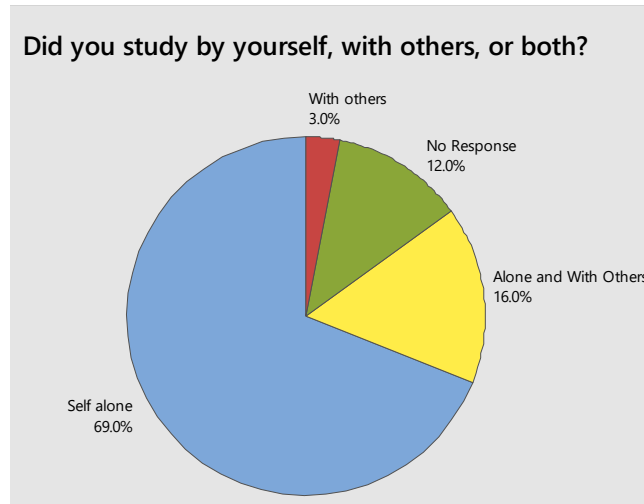
A) Response from both classes
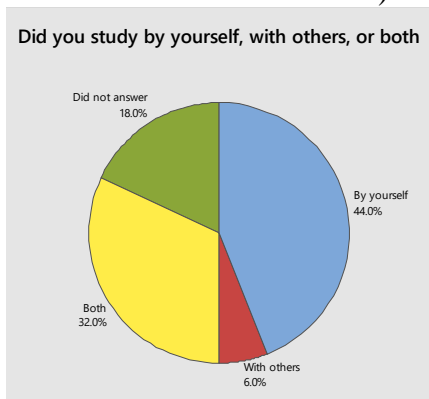
B) ENGR 275 Dynamics Studying plot


C) ENGR 382 SCADA Studying plot

Figure 4: Pie Charts of Summative Question 5 Responses
Did you study by yourself, with others, or both?
It has answers - 1: Self, 2: Others, and 3: Both.
A) Shows the results from Dynamics
B) Shows the results from both classes combined
C) Shows the results from SCADA

The last set of questions on the summative survey asks students to reflect on their performance on the exam once finished. The questions are listed in the label for Figure 5.
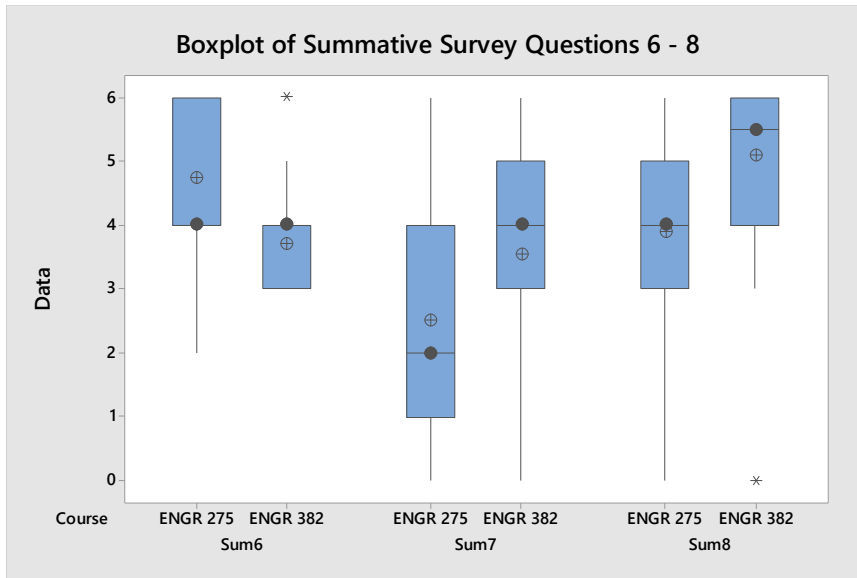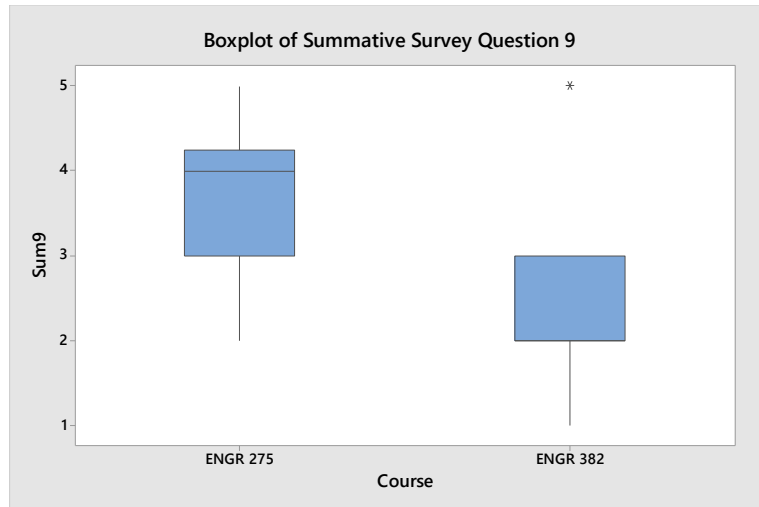
Figure 5: Boxplot of Summative Survey Questions 6 to 8

For convenient reference, the set of summative questions 6 – 8 presented in this figure are listed below.

Sum6:	In general, how much effort did the exam problems require? 1: Far Too Little, 2: Too Little, 3: Somewhat Too Little, 4: Somewhat Too Much, 5: Too Much, 6: Far Too Much
Sum7:	Did you study enough? 0: N/A, 1: Not At All, 2: Probably Not, 3: Maybe Not, 4: Maybe, 5: Mostly, 6: Definitely
Sum8:	Did the exam notes help? 0: N/A, 1: Not At All, 2: Probably Not, 3: Maybe Not, 4: Maybe, 5: Mostly, 6: Definitely

Overall, Dynamics (ENGR 275) has a much larger negative response from all these questions. Students indicate exam problems from Dynamics required too much effort, that they did not study enough, and that the exam notes may have been helpful; but not as much as SCADA (ENGR 382).

Finally, Figures 6 and 7 illustrate the results of summative Question 9: "What score do you think you will earn on this exam?" Figure 6 shows that students predict a much lower score on their dynamics exams vs their SCADA exams over the entire length of the course.

Figure 6: Boxplot of Summative Survey Question 9 responses

As a reminder, summative survey Question 9 (Sum9) is: What score do you think you will earn on this exam? Responses are ranked as shown below.

1: 90% to 100%, 2: 80% to 89%, 3: 70% to 79%, 4: 60% to 69%, and 5: <60%

In addition, when compared with their actual performance on their summative assessment, Figure 7 shows that students are good are predicting their performance on their exams.
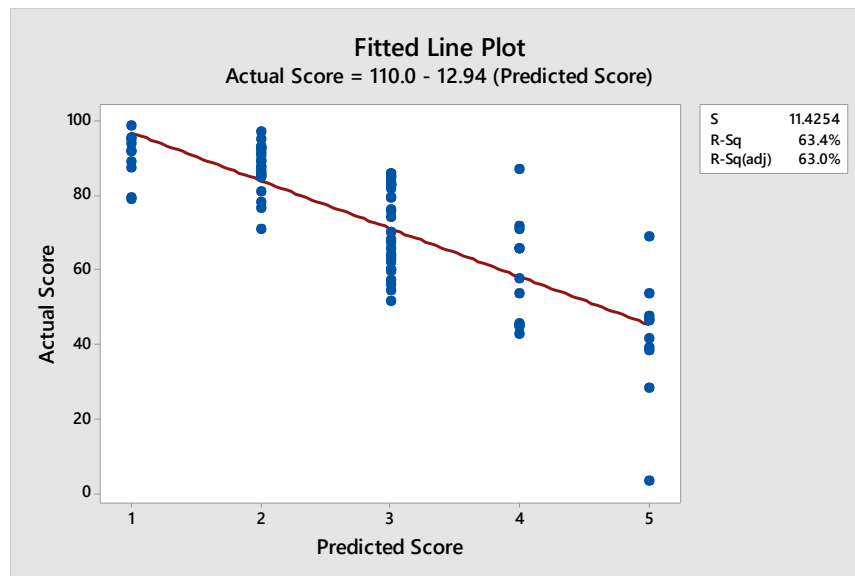

Figure 7: Fitted Line Plot of Predicted Score (Sum9) vs Summative (Exam) Score

This figure illustrates that students are good at predicting their summative/exam score after taking their exam

To inform students and have them reflect on the strategies they use to prepare for exams, we asked them: "How many hours did you spend studying for the exam?" The results for both
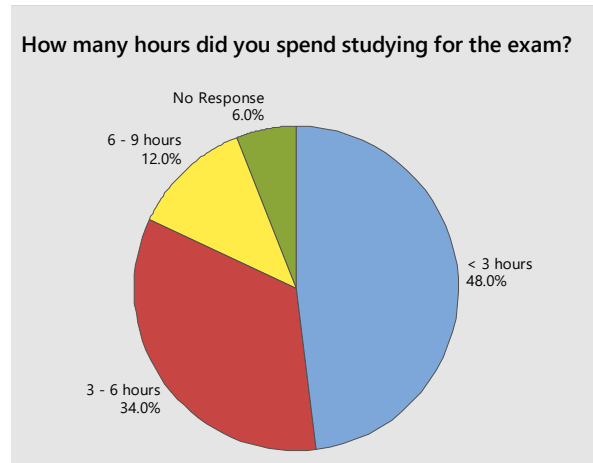
classes, together are shown in Figure 8, below. These results are further be broken down into each individual class – Dynamics and SCADA.

How many hours did you spend studying for the exam?
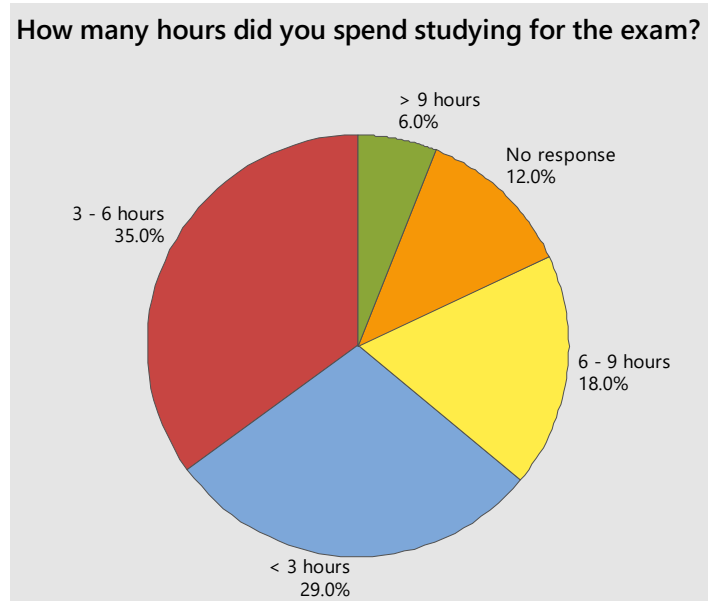
A) Response from Both Classes Study Time
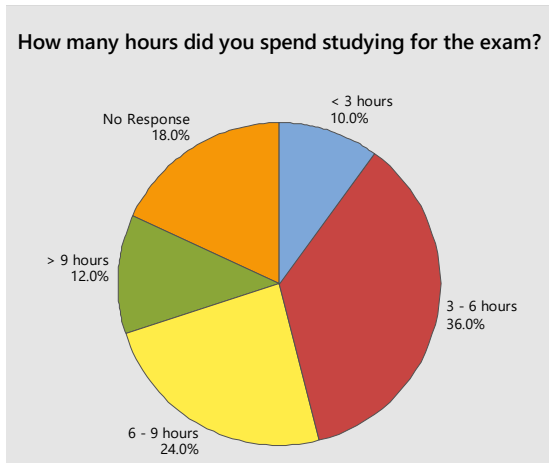
B) ENGR275 Dynamics Study Time

C) ENGR382 SCADA Study Time

Figure 8: How many hours did you spend studying for the exam

There is a large difference in time spent studying between the two classes. Just under half of SCADA's students spend less that 3 hours studying for exams, while about 46% spend less than 6 hours.

        A) Shows the results from both classes combined

        B) Shows the results from Dynamics

        C) Shows the results from SCADA

Sixty percent of students in Dynamics are spending 3-9 hours studying for exams, where as in SCADA, 82% of students are spending less than 6 hours studying for exams. This may be

an indicator of differences in quantitative and more qualitative courses and how students approach preparing for exams.

4   Discussion

There is significant variation between the two classes for summative questions 1 through 3 (see Figure 3). This indicates that students generally study, practice problems and read more for their Dynamics course. However, summative question 4 indicates that students in both classes feel that they understood what they did read. These responses may reflect the objective of each class – Dynamics (ENGR 275) is heavily analytical whereas SCADA systems (ENGR 382) is more qualitative.

Figure 4 explores how students study: alone, with others, or both. Figure 4 shows the breakdown of responses across both classes while Figure 1 is a boxplot comparing the two classes. One of the more interesting finding here is that all the SCADA students studied alone.

In Figure 5, students in Dynamics perceive that more effort is required on exam questions (Sum6) than the SCADA students. As with summative questions 1 and 2 (Sum1 and Sum2), this may be due to ENGR 275 being more analytical. In general, students never feel confident that they have studied enough after taking an exam (Sum7). SCADA students thought that exam notes helped more so than ENGR 275 did (Sum8).

In Figure 6, summative question 9 (Sum9), which asks students to predict their exam score, shows that students in Dynamics, on average, expected to score 60% to 79% whereas SCADA students expected to score around 85%. As suggested before, this may be due to the difference in analytical level between the two classes. What is interesting, shown in Figure 7, is that students across the two classes are good at predicting their actual exam scores.

5   Conclusion

In summary, although we found no correlation between perceived effort on formative and summative assessment when compared to summative assessments. There were trends in the more qualitative course (SCADA) that support the idea that as perceived effort goes up, summative assessments decrease. However, this is clearly not the trend in the more analytical course (Dynamics). This may support the idea that with the more analytical courses, students must practice solving problems to become more comfortable with analytical methods used in these courses.

In addition, after asking all our students to reflect on their study habits, and their perceived performance on exams, it was interesting to discover that the data show performance is not correlated with time spent studying. This seems so obvious to faculty, but now we have the data to show students, to inform them, about what they can do to succeed in their courses. This is shown in both a heavily analytical course (Dynamics) and a more qualitative course (SCADA).

Even more interesting is that none of the students in the SCADA class studied with other students. The conclusion we come to here, is that this may have been related to the type of course (analytical vs. qualitative) selected to include in this analysis, but we recognize that there are

several other factors that could influence this behavior. In the future we plan to revisit questions in the Formative and Summative surveys to help students and instructors to better understand criteria that leads to satisfactory performance.

6   References

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[3]   B. Stephenson, M. Craig, D. Zingaro, D. Horton, D. Heap, and E. Huynh, "Exam Wrappers: Not a Silver Bullet," *Proc. 2017 ACM SIGCSE Tech. Symp. Comput. Sci. Educ. - SIGCSE '17*, pp. 573–578, 2017.

[4]   R. N. Soicher and R. A. R. Gurung, "Do exam wrappers increase metacognition and performance? A single course intervention," *Psychol. Learn. Teach.*, vol. 16, no. 1, pp. 64–73, 2017.

[5]   P. Cunningham, H. M. Matusovich, J. R. Morelock, and D.-A. N. Hunter, "Beginning to Understand and Promote Engineering Students ' Metacognitive Development," *ASEE Annu. Conf. Expo.*, 2016.

[6]   R. C. Hibbeler, *Engineering Mechanics: Dynamics*, 14th ed. Hoboken, NJ: Pearson, 2016.

[7]   T. Bartlett, *Industrail Automated Systems: Instrumentation and Motion Control*, 1st ed. Clifton Park: Delmar (Cengage Learning), 2010.

Appendix A
Included below are the two surveys used in this study.

A.1 Summative Survey
Students are asked to reflect on their preparedness regarding this exam.

1. How many hours did you spend studying for the exam?

Less than 3 hours	3 hours to 6 hours	6 hours to 9 hours	More than 9 hours

2. Did you work/answer all the homework problems?

None	Some	Most	All

3. How much of the required reading material did you read?

None	Some	Most	All

4. What percentage of what you read did you understand?

0% to 24%	25% to 49%	50% to 74%	75% to 100%

5. Did you study by yourself, with others, or both?

Self	Others	Both

6. In general, how much effort did the exam problems require?

Far Too Little	Too Little	Somewhat Too Little	Somewhat Too Much	Too Much	Far Too Much

7. Did you study enough?

N/A	Not At All	Probably Not	Maybe Not	Maybe	Mostly	Definitely

8. Did the exam notes help?

N/A	Not At All	Probably Not	Maybe Not	Maybe	Mostly	Definitely

9. What score do you think you will earn on this exam?

90% to 100%	80% to 89%	70% to 79%	60% to 69%	<60%

10. Comments:

A.2 Formative Survey

Formative assignments are defined as homework problems, class problems, exercises, and quizzes. These are assigned to students and may or may be graded.

1. In general, how much effort did the formative assignments require?

0	1	2	3	4	5	6
Not Applicable	Far Too Little	Too Little	Somewhat Too Little	Somewhat Too Much	Too Much	Far Too Much

2. How many hours did you spend working these formative assignments?

A	B	C	D
Less than 3 hours	3 hours to 6 hours	6 hours to 9 hours	More than 9 hours

3. Did you feel prepared to tackle these formative assignments?

0	1	2	3	4	5	6
Not Applicable	Not Prepared At All	Mostly Not Prepared	Somewhat Not Prepared	Somewhat Prepared	Most Prepared	Completely Prepared

4. Comments: