

CALSTEP RESEARCH SUMMARY

Introduction to Engineering

Skyline College, Fall 2015

Key findings

- Students take the course too late; the average number of semesters completed was almost 5
- In comparing students' responses to questions regarding their engineering self-efficacy at the beginning and conclusion of the class, there was an increase in the number of students who felt more confident about their ability to complete transfer requirements in physics without a comparable change in students' confidence in their ability to complete math requirements for transfer. The finding may relate to the hands-on design projects that helped students understand the application of physics (see below). The pre- and post-surveys also found an increase in the number of students who knew what kind of engineering degree they wanted to pursue.
- Students learned success strategies and several mentioned they had been motivated by the course to more actively engage both inside and outside of the classroom
- The incorporation of metacognition was successful and points to the opportunity for additional experimentation into (and assessment of) this approach. In addition to using metacognitive strategies in the course itself, a remarkable 19 of 27 (70%) respondents said they have used metacognitive strategies in other courses they are taking.
- Students loved the hands-on design projects and wanted much more. The projects helped them understand physics, especially, but also math better and it served to motivate and increase students' excitement about the field of engineering
- Even though most students were well into their community college course-taking and most had many units and semesters completed already, many found that the course broadened their view of the wide range of career opportunities available in engineering – students reported changing their direction in engineering as a result. For several students the change in direction was also linked to the opportunity they had to “do engineering.” *(In my mind this raises the question of whether you can actually choose a career with confidence if you have only a theoretical knowledge of what the career choice involves)*

Comparison of students' engineering self-efficacy in pre- and post-survey

The pre-course survey was conducted on October 1, 2015, several weeks into the fall semester; the exit survey was conducted on December 17, 2015. Questions concerning students engineering self-efficacy were asked in the pre- and post-survey. Key findings from a comparison of the responses found that:

Students' confidence in their ability to complete math requirement for transfer did not change much over the course of the class. By contrast, there was a positive shift in the number of students who experienced an increase in confidence that they can complete the physics requirements for transfer.

I am certain I can complete the physics requirement for transfer in engineering	0 = "strongly disagree" 5 = "strongly agree"
Pre-course survey	68% responded with a 4 or 5 and 33% responded with a 2 or 3
Post-course survey	82% responded with a 4 or 5 and 19% with a 2 or 3

The number of students who were the most and the least confident in their ability to complete the physics requirements did not change much over the duration of the course, but more students shifted from the low end to the middle of the spectrum of confidence.

An even bigger shift occurred in students' assessment of their ability to cope with a bad grade on a math test.

I can cope with doing poorly on a test in a math class	0 = "strongly disagree" 5 = "strongly agree"
Pre-course survey	29% responded with a 4 or 5 and 36% responded with a 0-2
Post-course survey	56% responded with a 4 or 5 and 11% with a 2 or 3

Gains were also made in students' assessment of their knowledge about which courses to take in the first two semesters after transfer and in where to go for help with transfer questions. By contrast, there was little change in students' assessment of their knowledge about which courses to take to be ready for transfer – although this may be because they knew this before they started the class. There was also little change in students' assessment of their ability to find help with difficult material in their math classes. This finding may relate back to the students' response to the question about how confident they are in their ability to complete the math requirements for transfer (Note – worth or wise to share with math department at Skyline?).

Finally, the number of students who know which engineering degree they want to pursue increased markedly.

I know what kind of engineering degree I want to pursue	
Pre-course survey	57% said yes; 7% said no; 36% were uncertain
Post-course survey	78% said yes; 4% said no; 15% were uncertain and 4% had decided to no longer pursue engineering

Students' background at the community college

# semesters enrolled at CC, including fall 2015	Average for 28 respondents= 4.9 semesters Low was 3 semesters; high was 12 semesters
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# semesters enrolled full-time (12 units or more) at CC, including fall 2015	Average for 28 respondents = 3.8 semesters Low was 0 semesters; high 9 semesters
Highest level of math completed w passing grade N=29	1 College Algebra 2 Trig 4 Pre-Calc 6 Calc 1 6 Calc 2 1 Calc 3 5 Linear Algebra 4 Dif. Equations 24% in pre-calc or lower 21% in Calc 1 More than half in more advanced math courses (Calc 2 or higher)

Summary of Narrative Questions

Question 22: Please explain in one or two sentences how the class has influenced the way you think about yourself as a student (for example: I learned that going to class is only one part of being a successful student)

Quotes

I now understand that I need to actively pursue more outside opportunities about engineering rather than just going to classes and discussing related topics to engineering.

This class has taught me how to be the best student I could be. It has taught me not only how to academically succeed, but it also how to manage my time and my life.

I learned that I have still so much to improve on in terms of my methods of studying and making use of the people around campus and the resources.

Response Categories	# of responses (note several students identified responses in more than one category)
Importance of being a team player/how to work in teams	5
Finding/being motivated	4
How to fully engage and succeed as a student	13
Time management	6
Importance of active engagement beyond classroom	3
Range of engineering fields	3
Important of planning	2

Question 23: Please explain in one or two sentences how the class has informed your awareness of different engineering disciplines and influenced your thinking about the kind of engineering you want to pursue?

Quotes

I learned that software engineering isn't the major for me after I got to do design projects. It's also interested me in looking into robotics and how I need to learn how to code as soon as possible.

This course has confirmed for me what a mechanical engineer does. I have always had a rough idea of what a mechanical engineer was, but I can now say that I know for sure I am on the right field.

Because of this class, I now know many different types of engineering I did not previously know.

I was not aware of the difference between mechanical and electrical engineering - and their overlap. This class helped me affirm the discipline of study that I wanted to pursue.

Summary of coded responses

Response categories	# responses
Helped student choose, affirm or change engineering field	9
Increased/informed student's knowledge of range of engineering careers/fields	14
Deepened student's knowledge of what engineers actually do in various fields of engineering	7

Question 25: Please explain how/if the metacognitive problem solving approach (used for the mechanical properties of materials group problem) helped you understand the mechanical properties of materials.

Almost 90% of respondents, 24 of 27 students, felt the metacognitive approach has helped them think through problems before they try to solve them; organize their thoughts; understand their own thought process; break down complex problems; establish a problem-solving process

Quotes

Being aware of my own thought process has helped me organize my thoughts in away that enables problem solving. For example, on a test, breaking down complex problems into easier, more digestible component is a useful way of applying the metacognitive approach.

The metacognitive approach has helped me a lot, and I think that it is really good that Nick had us thinking a lot about an activity before we did anything with it. Being able to always have the concepts in my head due to constant metacognition I found myself able to figure problems out slightly faster than normal.

The approach allowed us to understand the mechanical properties of materials with a systematic yet simple method.

Summary of coded responses

Response categories	# responses
Helped problem solving/establish a process of problem-solving that the student used in this class	9
More generally helped student develop techniques/approaches to organize ideas and solve problems	10
Increased self-awareness for students on how they tend to approach a problem	5
Helped student develop/use different types of problem solving approaches (e.g., visual)	5

Question 26: Please explain in one or two sentences how/if you used the metacognitive approach in other courses (for example to compare your learning style to the teacher's teaching style -- or to annotate and talk to the text)?

More than 70% of survey respondents (19 of 27) noted they have used metacognition in other courses, including physics and chemistry. While many students focused their response on where they have used metacognition, about half of the respondents provided examples of how they used the approach in other course they took during the Fall semester.

Quotes

Yes, in chemistry. In Chem i have used this thought process to help me on tests. Metacognition helps me put my thoughts in order and helps me rely on a foundation of reasoning to solve difficult problems.

I used this approach in both physics and differential equations. Definitely helped a lot in both courses because when the time for an exam would come around it was a lot easier to review because the course material would constantly be on my mind.

I have in fact practiced the metacognitive approach in my other courses. Depending on how the class is taught and how the class functions, I will implement a learning style that will compliment the course outline and boost my chance of success.

With the approach, I was able to understand problems in other classes because I knew what I was looking for when reading the text.

Summary of coded responses

Response categories	# responses
Used to develop problem solving approach/organize thoughts	7
Used knowledge of different learning styles	5
Used note-taking approach	1
Used communication skills for team work	1

Question 27: Please explain in one or two sentences what you have learned from the design projects. For example, did they help you understand the application of math and physics and/or increase your interest in a particular field of engineering?

The responses to this question were the most enthusiastic of all responses collected. In addition to underscoring how the projects contributed to increase students’ understanding of math and physics, many students spoke of how working on the projects increased their interest, motivation and overall enthusiasm about engineering. Also, in the “what can be improved” section of the survey one –third of respondents (9 students) said they wanted more projects.

Quotes

As for the design projects, it actually struck an interest to me, and I found it exciting when it came to drawing out the design for the bridge. I'm planning to look into fields of engineering where I get to design because for some reason, I found it enjoyable and close to what I love, which is drawing.

From designing the projects in class I have learned to really appreciate having the knowledge to write code. I have always known that writing code is essential, but after being exposed to MATLAB and the Arduino, I have a much bigger interest for learning how to write code.

Design projects helped me understand that concepts of math and physics that are integral part of each project, because it helped demonstrate each subject in a simple manners.

The design projects helped me understand physics better. From the projects that we did in this class, I was able to apply it in my physics class.

Summary of coded responses

Response categories	# responses
Helped understand application of math and physics	9 physics /5 math
Increased motivation/interest in engineering	7
Helped learn how to write code	2
Helped build skills working in teams	3
Helped understand what engineering is all about/what engineers actually do	3