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Changing Student Behavior through the Use of Reflective Teaching Practices in an Introduction to Engineering Course at a Two-Year College

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Abstract

First-year engineering students are often underprepared for success in preparatory core classes. To support aspiring student engineers on their path towards degree completion, student behaviors and attitudes conducive to success as engineering students are developed through the use of reflective teaching practices in an Introduction to Engineering course. With a progressive series of student assignments, in-class activities, and weekly retrospective writing assignments, students are guided to reflect on class experiences. These tasks help students to use classroom learning to inform future decisions. Recognizing the diverse strengths and backgrounds of our students, the assignments emphasize multiple modes of reflective output, including written text, drawings, and both audio and video recordings. A culminating student project is also presented. The project is a reflective work centered on helping students to plan their personal development towards becoming a "world class engineering student" through the use of gap analysis.

Introduction

Student success in engineering is not only dependent on academic talent, but also the ability to develop the right attitudes and behaviors required to be successful in the demanding college coursework. At Highline College we focus on changing student behavior through the use of reflective teaching practices. A list of successful student behaviors is provided below:

- Successful engineering students have made education one of the top three priorities in their lives.
- Successful engineering students recognize the importance of goal setting and have clear academic goals. They meet with their academic advisors quarterly to keep their academic plan current.
- Successful engineering students schedule their time, utilizing time and priority management principles. They study on a continuous ongoing basis and have dedicated study time built into their schedule.
- Successful engineering students make effective use of their peers by engaging in group study and collaborative learning. They know the other students in their classes and feel like part of the academic learning community.
- Successful engineering students prepare for each lecture by reading ahead, working the examples in the text, and formulating questions.
- Successful engineering students take notes in class and rework lecture examples to verify their understanding of the material presented in lecture before the next class.
- Successful engineering students practice good test taking strategies. They follow a study plan, arriving for the test on time, prepared, and well-rested.
- Successful engineering students regularly seek advice and one-on-one instruction during their instructor's office hours.

- Successful engineering students have the ability to learn independently and master material not covered in lecture.
- Successful engineering students spend as much time on campus as possible to take advantage of available resources. They use on-campus programs and on-campus resources to help them achieve their educational goals.

These behaviors align with behaviors discussed in many publications on student success and student retention.[1234]

Student Population

Highline College is an open access two-year college located south of Seattle, WA and within 10 minutes of an international airport. During the 2014-2015 school year, 161 students enrolled in our Introduction to Engineering Careers class over fall, winter, and spring quarters. Students self-selected enrollment into the course which has no pre-requisites. Of the students who self-reported their race and/or ethnicity, 65% identified as being students of color, as shown in Table 1. This suggests a racially and ethnically diverse demographic. In addition to racial and ethnic diversity, our engineering students are culturally diverse. Collectively, a class of Introduction to Engineering students can be expected to speak nearly 20 different languages fluently, with greater than two out of three students being multilingual.

In addition, many of our students were enrolled in a dual degree program where they have the opportunity to take college credit classes as junior or senior high school students. 26% of our students were considered to be high school students attending college. On the other hand, 16% of our students were non-traditional students over the age of 25 years old.

Our students also demonstrate significant financial need. Approximately 40% of our college's credit-earning students received financial assistance through the college's Financial Aid office during the 2015-2016 academic year. Dual-degree students are not eligible for financial aid in that their tuition is paid by Washington State as part of their high school completion.

Table 1: Diversity of Introduction to Engineering Students for School Year 2014-2015.

Race / Ethnicity	Percentage
African American	8%
Asian	28%
Hispanic/Latino	13%
Native American or Alaska Native	0%
Native Hawaiian/Pacific Islander	1%
Multiracial	13%
Other	2%
White/Caucasian	35%

* This data excludes 27 international students.

Our engineering students are also significantly underprepared for study in engineering. Less than 20% percent took calculus as their first math course at Highline College, as shown in Figure 1. Over half of these students started in Algebra 2 or below, requiring at least a full year of math education before they could enroll in calculus.

Results

The first calculus course is generally considered the starting point to a four-year engineering degree. It lays the fundamentals for engineering core classes, as well as other common engineering science requirements such as calculus-based physics. Adding a year or more of engineering prerequisite courses represents an approximate 25% increase in time to degree. Given the fact that our students demonstrate significant financial need, this increase in time to degree constitutes a substantial financial burden. This suggests that students who begin at a math level below calculus, and continue to pursue a degree by taking engineering courses at our college are exceptionally persistent.

Persistence is an important factor to consider among our engineering students. Persistence here is defined as continuing to identity oneself as an engineering student after taking the Introduction to Engineering course, and continuing to take engineering prerequisite courses in-series. Of the 161 students who enrolled in our Introduction to Engineering course during the 2014-15 school year, 58% of students were continuing to pursue a degree in engineering during fall quarter of the following school year (2015-2016). As shown in Figure 2, persistence is significantly impacted by a student's first math course taken at our college. For example, 76.7% of students who started in Calculus were persistent, while only 6.8% of students who started in Pre-Algebra were persistent.

In combination with persistence, transfer rates are another metric through which our student population can be better understood. Each year, approximately 40 students earn an Associate of Science Degree and transfer to engineering programs at four-year schools. Because many students elect to transfer without applying for an Associate Degree, it can be estimated that the actual transfer rate is approximately 50-60 students per year. In our state, it is most common for students to apply to engineering programs, starting core engineering courses within their major at the beginning of their junior year. For our transfer students, this implies that they apply directly for admission to the engineering program of their choice within the four-year school that they will be attending.

We estimate that of the 161 students who took Introduction to Engineering during the 2014-15 school year, a minimum of 35% will transfer to a four-year school to major in Engineering. Data for second and third-year students is more difficult to track because many students leave the institution and transfer without completing a two-year degree. Also as a result of a student's starting math level, they may spend three years at our school, but only be ready to transfer into third year or junior level engineering classes at a four-year school.

In 2016, ASEE reported the average second year persistence of 56,393 undergraduate engineering students who started college in 2007 at 76.30%.[5] The same study reported third year average persistence at 64.60%. Although our persistence figure may be half that of the 64.60% average for traditional engineering college students at four-year schools, we feel that our

Figure 1: First class taken by Introduction to Engineering Students.

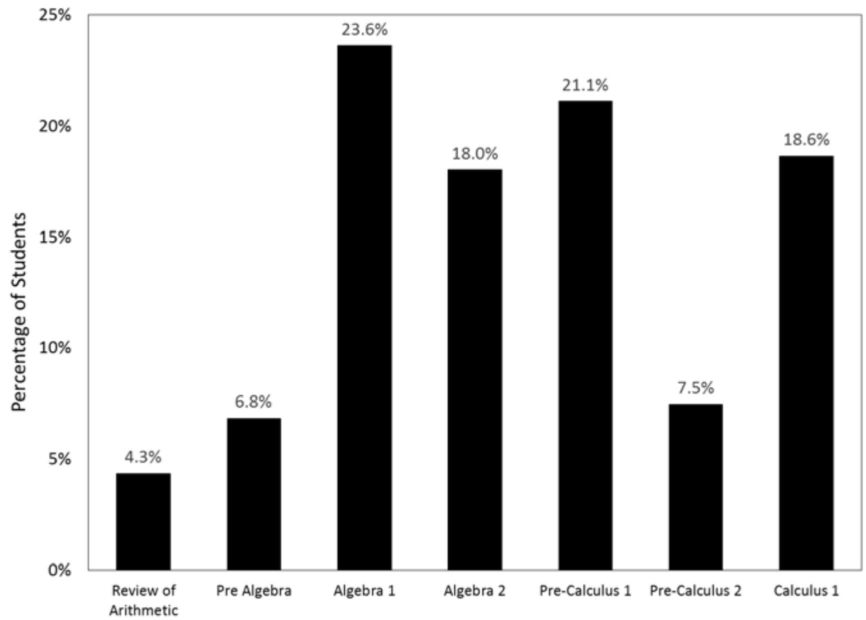
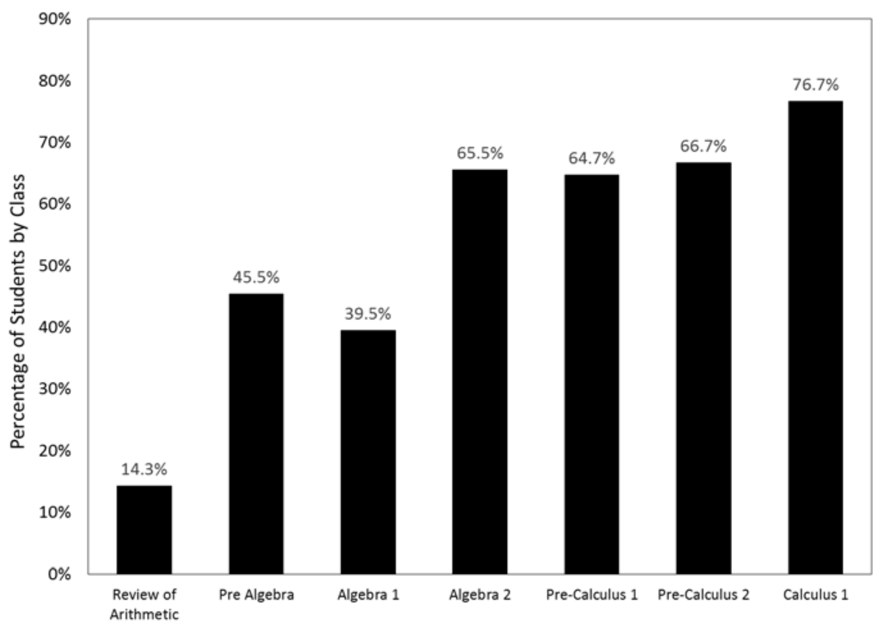


Figure 2: Persistence by first math course taken at our college.



*Our course names have been adjusted in Figure 1 and Figure 2 to reflect more commonly used course names in math education. All courses are ten weeks long and on the quarter system.

data still compares favorably. Our students are beginning their college education far less prepared in terms of core engineering prerequisites, especially mathematics. There is a strong link between high school students who take courses in advanced mathematics to the eventual choice of a STEM major [6]. Related to this idea, in a separate review, unrelated to our college, after analyzing data from 129 college freshmen who self-identified as engineering majors, calculus readiness was a strong predictor of engineering retention [7]. Given that a mere 18.6% of incoming students who enter our Introductory Engineering course are ready to take calculus, it is clear that a larger proportion of our students are underprepared for engineering, and therefore less likely to be persistent.

The Introduction to Engineering Course at Highline College.

Given our underprepared, underfunded, and diverse student population, we have been required to change our approach to our Introduction to Engineering course over the last ten years. In 2005, our goal was to provide a general overview of engineering careers, and a summary of the classes needed to transfer in a one-credit, hour-long course that met one day per week. The course was primarily taught using PowerPoint presentation slides where guest lecturers spoke on the merits of one of the disciplines in engineering. Though the course had an optional textbook, *Studying Engineering*[1], by Ray Landis, learning was confined to the classroom, as no incentive was given to the students for interacting with the textbook. Student engagement was low. Students attended the course because grades were primarily assigned according to attendance, but they often showed up late, or sat near the back of the classroom. The success of our course was further complicated by our expectation that our students, many of whom were recent high school students, knew how to behave in a classroom setting as college students.

As a result of using Landis' textbook, *Studying Engineering,* for the course, we received an invitation to attend a three-day, Chautauqua short course hosted by Landis entitled, "Enhancing Student Success through a Model Introduction to Engineering Course" in June of 2008. In the workshop, Landis stated that, "an effective student success course focuses on bringing about behavioral and attitudinal change in areas related to five key themes: Community Building, Professional Development, Academic Development, Personal Development, and Orientation."[8]

As a result of our time at the short course, we recognized the gap between our current students, and model engineering students. We adopted a classroom model focused on changing our students' attitudes and behaviors and embraced the goal of teaching our students to become better engineering students. In order to accomplish this we adopted three new course outcomes that had been presented at the workshop:

- Strengthen our students' commitment to a career in engineering
- Connect our students with each other
- Develop substantive behavioral and attitudinal change in our students which they can articulate

Building student commitment to a career in engineering requires helping our students envision themselves as future engineers, with a balanced understanding of what it will take to achieve that goal. Although engineering degrees are often earned through great personal sacrifice, students need to know they are achievable if they are willing to commit to making the necessary changes in their approach to being a student.

Secondly, it is important to connect students to each other in order to build a supportive educational community. Engineering is too challenging for most students to go the distance alone. Often, students will not know the first and last name of more than three or four students in any of their classes. In contrast, Introduction to Engineering students are required to learn the first and last names of all of their classmates.

Finally, at the end of the class we want students to be able to describe how they approach their education differently in order to be more likely to reach their educational goals. Dweck's ideas in *Mindset: The New Psychology of Success* resonate strongly in support of this approach to student success. In her book, Dweck highlights that success is not only dependent on talents and abilities, but also whether one has a growth-oriented mindset as opposed to a fixed mindset [9]. It is our goal to help students achieve this growth-oriented mindset.

Changing Student Attitudes and Behaviors

Convinced that we needed to change our students' attitudes and behaviors, we moved forward, looking for a catalyst for change. Introspection tells us that change within the context of our personal lives is not necessarily easy to achieve. One often hears the adage of health-related advice that exercising 30 minutes every day, eating a healthy diet, and sleeping eight hours every night will result in more efficacy and greater satisfaction. It is clear that this advice is not universally followed. Simply knowing what to do is often not motivation enough to generate effective lifestyle changes.

Connecting this evident discrepancy between knowledge and action to a classroom setting, an instructor may be asked: "If you tell your students continually what they need to do to be successful in your classes, why do some students not follow your advice?"

In our Introduction to Engineering course we have found that we cannot just tell students how to behave and expect them to change their behaviors. Neither can we tell our students how to think and expect them to learn. This can easily be demonstrated in the class by assigning students to groups, and asking them to make a list of strategies needed to be successful in their math class. With ease, students develop a protracted, comprehensive list of strategies. Based on the acuity of responses, one might deduce that they were all were near-perfect math students. Suspecting that students are likely to display a normal distribution of math aptitude, a follow-up exercise highlights the problem at hand. After creating the list, student groups are asked to review each strategy, crossing it off the list if more than half the students in their group are not regularly implementing the strategy. A common finding is that most lists are significantly reduced. As a follow-up, students are asked to develop a list of reasons why they are not practicing the math study behaviors that they crossed off, despite knowing that these behaviors are conducive to success. This activity underlines the concept that knowing what successful behaviors are, or look like, does not make a student successful. Students must knowingly implement the strategies to be successful. This raises the question of motivation for change.

How can educators foster change in students' attitudes and behaviors? Work at our college has demonstrated that as instructors, we must create classroom-based student experiences. Moreover, experiences must motivate change by mandating student introspection through the process of reflection. To this effect, we believe that a series of carefully guided reflective activities is the beginning of positive change in the behavior and mindset of our students.

Reflection

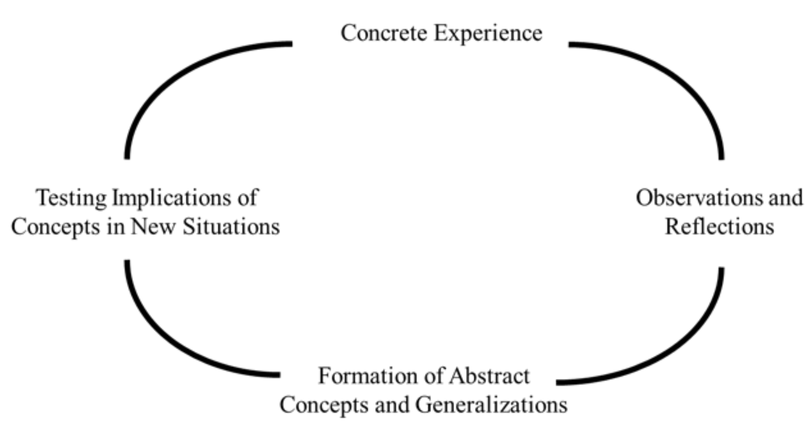
How is reflection defined within the confines of higher education? Reflection is the process of deriving meaning from one's experiences with the intent to inform future actions, while considering the influence of one's own personal history. According to David Boud and Rosemary Keogh, "reflection is a form of response of the learner to the experience." They outline reflection as consisting of two different phases: the experience, and iteratively circling back on the experience during reflection. What motivates reflection on the experience? Twentieth century philosopher, John Dewey suggests that doubt or confusion following an event can lead to critical thinking to sort through existing data and prior knowledge.

> Reflective thinking is always more or less troublesome because it involves overcoming the inertia that inclines one to accept suggestions at their face value; it involves willingness to endure a condition of mental unrest and disturbance.[10]

The need for mental unrest and disturbance to motivate reflection promoted by Dewey is paralleled by Boud and Keogh. They suggest that inner discomfort motivates the learner to reflect [11]. Dewey also suggests a need for the learner to suspend judgment, as critical thought is crucial for reflection. This concept then builds a framework for changing student mindset, similar to the ideas of Dweck. Another framework that can be easily overlaid these ideas is Kolb's learning cycle. Kolb's learning cycle uses a concrete student experience to iteratively reflect, and deepen one's learning.

Kolb's learning cycle shown in Figure 3 uses a concrete student experience to iteratively reflect and deepen classroom learning. According to Kolb, after having a concrete experience, students make observations, reflecting on the experience. This is followed by formation of abstract concepts and generalization, finally leading to testing these concepts and generalizations in new situations[12]. The beauty of Kolb's model lies in a learner's ability to use reflection on a single experience to view the event in a more abstract way. This allows them to make a flexible template out of their experiences that can then be applied to new situations. Because reflection plays a pivotal role in a student's ability to apply classroom knowledge to real-world applications, we feel that reflection is a keystone in enhancing student learning.

Figure 3: Kolb's Learning Cycle



Building off of Kolb's learning cycle, an important factor to consider in helping students to reflect involves the way that students make meaning of the experience itself. Each student likely has different prior knowledge, and self-concept. This understanding is pivotal given the intellectually and culturally diverse students taking our Introduction to Engineering course. Aspects of a student's background and prior knowledge impact a student's progression in Kolb's learning cycle during both observation and reflection, and formation of abstract concepts phases. In short, through reflection, a "person revisits an experience with a specific meaning making lens." [13] In developing reflective activities for Introduction to Engineering, it was important to consider that each student might use a different lens to make meaning of the same activity. Perhaps equally crucial, if a reflective activity is to inform future student actions, it needs to capable of filtration through a variety of student lenses, allowing a diverse group of students to reap the benefit of the activity. This emphasized the downstream impact that student activities might have as they were being designed, and allowed us to come up with four questions for instructors to consider in developing their own reflective activities.

When developing reflective exercises, it is important that an instructor be able to answer the following four questions:

- What experience will you create for your students?
- What meaning do you expect your students to derive from the experience?
- What changes would you like to see in your students' future actions?
- How will your students' personal histories impact your reflective activity?

Course Overview

In fall of 2009 we expanded our Introduction to Engineering course, making it a two-credit course that met twice weekly for 50 minutes. And outline for the course in shown in the Appendix in Table A.1. This format allowed us to focus more time on student development. The key elements of our current course are listed below.

- Weekly reading quizzes over material covered in the textbook
- Weekly reflective assignments based on material content from the textbook
- Weekly 250-word written reflections focused on in-class activities during the week
- A final exam on classmates' names
- A final student design project

Using our course management software, students are required to complete reading quizzes for the material in the textbook. Although not the best choice pedagogically to teach pertinent information, it is an efficient way to hold students accountable, engaging in course material before attending class.

The in-class lecture and discussion topics are outlined by day in the Appendix section for the entire course. The topics, located in Table A.2, cover a wide range, from an overview of engineering careers, to paying for college. However, each class topic can be directly mapped to our three new course outcomes: Strengthening our students' commitment to a career in engineering, connecting our students with each other, and developing substantive behavioral and attitudinal change in our students which they can articulate. The in class activities are designed to serve as student experiences upon which they are later asked to reflect. Many emphasize multiple modes of reflective output, including written text, drawings, and both audio and video recordings. This broad spectrum of outputs allows us to meet the needs of students with a wide variety of student lenses. The weekly reflective assignments based on material content from the textbook are shown in the Appendix in Table A.3.

Each week, students are also required to write a 250-word reflection related to a topic covered in the class during the week. Each of the written reflections is briefly outlined in a Table A.4. For example, after visiting the computer lab to learn about cloud computing using Google Calendar and Google Drive, they are asked to reflect on the value of saving data in the cloud, and explain how it will benefit them in the future. Most importantly we are asking students to reflect and process the experiences that we created in the classroom in hope that they will make changes to their behaviors. In one case, a student might possibly adopt using an online calendar synced to their cell phone to be more effective at managing their time. In another case, a student might struggle greatly with the technology based on the lack of experience with computers and chose to continue to use a paper calendar.

Students are required to demonstrate their ability to know the names of all of their fellow students in the class on the final exam. Names are essential to building student camaraderie in the class and across our engineering program. Given the diversity of students at our college, names also can serve as cultural identifiers and a strong sense of pride for our students. There are also several build-oriented engineering activities on the class schedule. These activities are just as much about building student connection as learning about communication or engineering design.

At the end of the quarter, students are required to complete a final project similar to the "Design Your Process of Becoming a World Class Engineering Student" project outlined by Peuker and Landis. [14] This reflective exercise serves as the culmination of a series of smaller, more focused reflections throughout the quarter. Our students are specifically asked to complete a gap analysis regarding eight essential behaviors of successful engineering students. For each attitude or behavior, students are asked to identify where they currently are doing and what changes they need to make in order to become a world-class engineering student. The template for the assignment is included in Table A.4 in the appendix. Students are also asked to reflect on how the class has helped them to develop in the areas listed in the table, as well as what specific things they have learned that will be valuable in their career as an engineer.

The "Design Your Process of Becoming a World-Class Engineering Student" project also serves as a benchmark for the success of the instructor. Below, we have included several excerpts from the final projects of our students.

Student 1:

> Before this class I had no concept of the actual steps, in detail, which would lead me to become an engineer…Engineering is a demanding field and this class has delineated what it will take to meet those demands. With a better perception of challenges I will run

across I can better prepare by strengthening coping skills I already possess and learning the required skills I lack. I was a list-maker by habit but the class revealed the importance of regularly updated academic blueprints not only quarterly but monthly and weekly…We are near the end [of the quarter] and I can look back over each week's exercises and assignments and see so much preparatory action and relevancy for years to come.

Student 2:

While I was doing well in school before this Engineering 100 class, I still gained a lot of knowledge about how to succeed in a specifically engineering-centered education. In the past, I went about my education with a "lone-wolf" mentality; never asking for help and always working on my own…[A]fter learning about getting the most out of resources offered at Highline and friends taking similar courses, I started using these strategies and they saved me a lot of time and have improved my self-esteem...These things, among many others have taught me the importance of good time-management and efficiency in engineering.

Student 3:

This class has helped me to develop my study skills by emphasizing group study, which I will begrudgingly admit, is better...I have developed better study habits and really changed the way I thought about engineering as a whole. In terms of where I am now and where I need to be, I don't think there is a whole lot of separation between the two. I need to put the work in to get where I need to be but I can do it…I feel like it will be difficult to succeed in Engineering, but to me nothing worth having is ever easy.

Student 4:

I feel that this class has helped me in a myriad of different ways. For example, the build exercises we have performed in this class have helped me improve my improvisational skills, as well as my ability to work as a member of a team. However, I feel that the most important thing that this class has taught me is to treat education as a reflective learning process…In short, the most important thing that I learned was to think critically and reflectively about everything that I do so that I can capitalize on my own strengths and work around my weaknesses. In summary, this class has taught me to think of education as a dynamic process. Over the course of this quarter, I have learned that when you attend school you must not only improve your understanding of class material, but also improve your understanding of yourself. It is imperative to be constantly observing and taking note of your own academic habits and behaviors."

Student 5:

In conclusion I enjoyed this class, but it made me figure out what I really want to do with my life. I want a hands on job with horses…Even though I didn't learn much about horses, I did learn that I don't want to be an engineer.

Changing Attitudes and Behaviors beyond our Introduction to Engineering Course

We find that student development is not complete at the end of our Introduction to Engineering Course. The course is the motivation for an educational journey. It gives students a framework, with tools for achieving their goals as students. In this way, at the end of the course, students are not finished products, rather, they have quality starting materials, and blueprints for their education.

We have found it important to continue to work to change student attitudes and behaviors through every interaction that we have with our students on campus. Whether it is an advising appointment, through a conversation on the bus to visit a four-year college, or during a post exam results review, we attempt to create life-changing experiences.

We have also incorporated many other reflective practices across our engineering coursework at our college. For example, students are required to reflect on the performance of their engineering projects, highlighting three improvements before the second phase of testing in their Engineering Dynamics course.

Conclusion

Our college has demonstrated success at helping underprepared, underfunded, and culturally diverse students reach their goals of graduating with engineering degrees. Through the work detailed here, we propose a framework of guided reflective activities that help incoming first-year engineering students in the course, Introduction to Engineering to become engineering students. The reflective activities that we have described help our students to shift their mindset from student to engineering student. By nature, these reflective activities are inclusive of the culturally and intellectually diverse population that we educate. Although our students are by no means finished products at the conclusion of the course, we can already see definite indices of success, including, but not limited to the favorable persistence factor of our graduates. We are convinced that our success is a result of developing the attitudes and behaviors of successful engineering students in our students through the use of reflective teaching practices.

The authors also acknowledge that given the size of our student population, approximately 300 students total, and the integration of reflective practices across our student support structure, it would be impossible to run a parallel Introduction to Engineering course which did not include reflective practices to serve as a comparison.

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Appendix

Table A.1: Typical Introduction to Engineering Careers Course Schedule

Week	Day One	Day Two	Reading Quiz	Reflection Topic	Assignment Topic
1	Syllabus Overview Introductions Behavior Survey	Newspaper Towers		Newspaper Towers	Getting to Know Highline Syllabus Quiz
2	Time Management and Scheduling	Google Suite in Computer Lab	Ch 1: Keys to Success in Engineering Study	Using the Cloud	Weekly Schedule Goals Worksheet
3	Engineering Careers	Foil Boats	Ch 2: The Engineering Profession	Foil Boats	Engineering Profession
4	Learning Styles	Straw Towers	Ch 3: The Teaching and Learning Process	Hiring and Firing	Teaching / Learning Process
5	Industry Guest Speaker	Ethics	Ch 4: Making the Most of How You are Taught	Ethics	Tutoring Center
6	Industry Guest Speaker	Name Practice	Ch 5: Making the Learning Process Work for You	Names	Success in Math
7	Industry Guest Speaker	Success in Math	Ch 6: Personal Growth and Development	Success in Math	Keirsey Sorter
8	Broadening Your Education	Cup Stack	Ch 7: Broadening Your Education	Building a Cup Tower	Broadening Your Education
9	Financial Aid	Open Day	Ch 8: Orientation to Engineering Education	Paying for College	Ethics - NPSE Ethics - Plagiarism
10	Practice Final Names	Final Exam		Final Reflection	Academic Plan

Table A.2: Introduction to Engineering Careers Course Lecture Topics

Week	Day 1	Description	Day 2	Description
1	Syllabus overview, introductions, and behavior survey	Students receive an overview of the organization of the course for the quarter, and complete introductions. Students also fill out an initial behavioral survey to assess where they are in terms successful behaviors.	Building Activity: Newspaper Towers	Introduce and help students with the activity, Newspaper Towers.
2	Time-management and scheduling	Discussion of time-management for engineering students, and introduction to the goals and time-management worksheet.	Lecture in the computer lab	Introduce Google's suite of tools for students, including Google Mail, Google Calendar, and Google Drive as a form of cloud-based storage.
3	Engineering Careers	Help students to become aware of the diversity of engineering careers available for them to explore and the processes associated with earning an engineering degree.	Building Activity: Aluminum Foil Boats	Introduce students to the activity, Aluminum Foil Boats.
4	Learning Styles	Introduce and discuss different student learning styles, emphasizing the importance of customizing one's learning according to personal preferences	Building Activity: Straw Towers	Introduce students to the activity, Straw Towers.
5	Industry Guest Speaker	An invited guest speaker from industry, preferably a graduate of the college lectures. Guest speakers preferably represent different disciplines.	Ethics	Complete the Ethics Reflective Activity. Activity focuses on scenarios students are likely to encounter.
6	Industry Guest Speaker	A different invited guest speaker from industry, preferably a graduate of the HC Engineering Program. Guest speakers are selected to represent different disciplines, cultures, and gender identities.	Name Practice	Students have time to practice the names of their classmates that they have been learning since the first day of class. Students are given time to add names to class picture set.
7	Industry Guest Speaker	Guest speakers preferably represent different disciplines. A third invited guest speaker from industry, preferably a graduate of the college lectures.	Success in Math	Students develop a list of success strategies in a math course and reflect on why they may not be implementing known successful strategies.
8	Broadening Your Education	Provide an overview of different ways to get involved within the collegiate environment outside of class. These opportunities can include, but are not limited to clubs, tutoring, and interest/study groups.	Building Activity: Cup Stack	Introduce and help students with the activity, Cup Stack.
9	Financial Aid	Help students to see the importance of seeking financial aid. Topics include filling out FAFSA, as well as looking for scholarships and networking.	Open	This day is meant to be free time for the instructor to lecture on a topic of their choice.
10	Practice Final: Names	Students practice matching each of their classmates' names with their faces in preparation for the final exam. Students also peer-edit a draft of the final project.	Final Exam	Students match each of their classmates' first and last names with their face for the final exam. Students rework initial surveys documenting the changes in their behaviors.

Table A.3: Introduction to Engineering Careers Course Assignments

Week	Assignment Topic	Description
1	Getting to Know Highline and Syllabus Quiz	Students complete a guided activity to learn about campus resources. After reading the syllabus, students test their knowledge of classroom expectations.
2	Weekly Schedule Goals Worksheet	Students complete a weekly schedule for their clases, work hours, and study time. Students identify one and five year goals in four categories: live, learn, work and play.
3	Engineering Professions	Students look into different engineering professions, select one of interest, and use practical information to fill out a writing assignment.
4	Teaching and Learning Process	Students take a survey to assess their learning styles, then write about how this knowledge could benefit them as students.
5	Tutoring Center	Students are required to visit the campus tutoring center, work with a tutor (and get their signature), then write about the experience.
6	Success in Math	Students are required to meet with their math instructor in their office hours to assess how they might become better math students. The students then receive the instructor's signature, and write about the experience. Both the conversation and act of visiting an instructor office hours are significant.
7	Keirsey Sorter	This assignment begins with taking a 70-question online questionnaire. Called the "Keirsey Sorter," this questionnaire is designed to help participants to learn about their personality type. After reviewing their results, students are asked to assess how accurate the results are, and three ways that this information can help them.
8	Broadening Your Education	This activity emphasizes the importance of broadening one's education outside of class. Students are asked to address how they might enhance their learning by participating in clubs, internships, or volunteer work. They are specifically instructed to pay attention to the impact that these activities might have, and describe initial steps that they have taken towards broadening their education.
9	Ethics: National Society of Professional Engineers (NSPE)	Students are asked to visit the website for the National Society of Professional Engineers (NSPE). They then read through a list of ethical cases handled by the board, and select one to write about. In a brief essay, they describe the case, how they would have handled it, and what conclusions were made by the NSPE board.
9	Ethics- Plagiarism	For this assignment, students review an online tutorial about plagiarism offered through the college library. They then take the associated quiz, repeating if necessary until they achieve a perfect score.
10	Academic Plan	Students schedule a 30-minute appointment with and engineering faculty member to complete a detailed academic plan outlining all of the courses that they will need to take before transferring to a four-year institution.

Table A.4: Introduction to Engineering Careers Course Reflection Topics

Week	Reflection Topic	Reflection Description
1	Newspaper Towers	Students reflect on their use of the Engineering Design Process during the in-class build activity.
2	Using the Cloud	Students reflect on the value of saving data in the cloud, and explain how it will help them in the future.
3	Foil Boats	Students reflect on their use of the Engineering Design Process during the in-class build activity.
4	Hiring and Firing	Students read a journal article about the "hiring and firing" of college graduates, then write a written reflection.
5	Ethics	Students reflect on an in-class ethics activity and answer the question, " Do you believe that small compromises in ethics today will eventually lead to larger compromises in ethics in the future? "
6	Names	Students reflect on the importance of knowing the names of other people and how it may benefit them during their career.
7	Success in Math	Students listen and discuss different strategies for studying math. After compiling a list of good strategies, students select and write about one that will enhance their learning in math.
8	Building a Cup Tower	Students reflect on the importance of good communication during the in-class cup tower assembly activity.
9	Paying for College	After an in-class visit from a financial aid advisor, students discuss how they plan to pay for college.
10	Final Reflection	Students recall their first quarter at Highline, then provide written advice for their former-self.

Table A.5: Introduction to Engineering Careers Course Design Project Template

Student Name
ENGR 100
Final Project: My Process for Becoming a Successful Engineering Student
DD Month Year

Replace the name and date above with your name and the due date

Insert an introductory paragraph here that introduces your process. This should be a five sentence paragraph. The first sentence introduces your topic, the middle three are supporting sentences and the final sentence summarizes and concludes the introduction.

Complete the table below. Be sure that you use complete sentences, with proper grammar and correct spelling. Each box in the table should contain between 3 and 5 sentences to fully address the topic.

Item	Where I currently am on this item	What I need to do to move from where I am now to becoming a "world-class" engineering student.
1. My goal is to graduate with my degree in engineering.		
2. I understand the essence of engineering and have a global awareness of engineering careers (academic disciplines, job functions, industry sectors).		
3. I have a current academic plan and will update it each quarter with my engineering advisor.		

4. I am building relationships that will benefit me during and after college.		
5. I use campus resources to support my academic goals. (give specific examples)		
6. I am becoming effective at managing time and tasks. (give specific examples)		
7. I practice best study skills and academic success strategies (explain what these are)		
8. I am involved in appropriate extra-curricular activities. (give details of activities)		

Insert a paragraph here that discusses how this class has helped develop you in the areas listed in the table. What specific things have you learned that will be valuable to you in your career as an engineer? This should be a five sentence paragraph. The first sentence introduces your topic, the middle three are supporting sentences and the final sentence summarizes and concludes the paragraph.

Insert a final paragraph here that is your conclusion. Use the five sentence paragraph structure to organize your conclusion.