WIP: A focus on well-being to increase non-calculus ready students' problem-solving self-efficacy

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Introduction

This work-in-progress paper is focused on studying how a focus on well-being is incorporated into a first-year engineering two-course sequence focused on physics and modeling with an instructional focus on problem-solving. The two-course sequence (EF141 & EF142) was developed at our university for non-calculus ready students in engineering. Previously, students in engineering that were not calculus ready when they arrived at the university would enroll in a pre-calculus course (MATH 130) and eventually enroll in their first engineering physics courses in the spring or the following fall once they passed pre-calculus. However, only about 60% of these non-calculus ready students ever made it into their first engineering physics course. To address the retention of these students, a new course sequence was proposed that would take the first physics course and the computing and modeling course and incorporate student success measures to help these students adapt more readily to college life and the rigors of engineering.

The two-course sequence was piloted in the 2021-2022 academic year and was taught 3 days a week. Through our first implementation, we saw the need for increased self-efficacy and confidence and ways to help students manage high stress levels in their first year of the engineering curriculum. We believe that a focused effort on well-being and academic support will have a positive impact on students' beliefs about their ability to succeed in engineering as well as their ability to manage high course workloads in courses, thus impacting retention of this specific population of students. To incorporate more focus on well-being and student success, the course credits were increased to allow for more contact with these students and dedicated time in the classroom for a focus on well-being, introduction to resources on campus, and academic success interventions.

This work, conducted with support from an internal student success grant, has just completed the first year of data collection. Our goals for this project are to (1) develop increased confidence (self-efficacy) in ability to achieve in math and physics concepts and (2) understand how mindfulness can impact these students' mental, physical, and emotional well-being and be incorporated into the classroom. To assess the impact of incorporating well-being measures into the classroom, we are using quantitative and qualitative research methods.

Methods

Course Context & Participants: Each course of the two-course sequence is taught five days a week with three 50-minute lecture sessions on Monday, Wednesday, and Friday and then two 75-minute lab sessions on Tuesday and Thursday. The courses are delivered in a flipped classroom model where students read the learning content and watch videos in preparation for problem-solving sessions during the lecture sessions. As both physics and computational modeling content is covered along with well-being and student success interventions, the two courses have been structured to have physics content for Monday with a corresponding lab on Tuesday, then computational modeling content for Wednesday with a corresponding lab on Thursday, and each week ends with content related to well-being and student success for Friday. The problem-solving sessions on Monday and Wednesday usually begin with a quick review of the material, the instructor will then walk through a problem with the students and lastly provide similar problems to be worked out in a group setting so students can familiarize themselves with the problem-solving structured process used in our courses. Students are then let loose to work on their individual practice assignments while instructor(s) and undergraduate teaching assistants walk the room answering questions. The Friday class sessions cover topics such as study skills, campus resources, career development, and well-being. For many of these sessions guest speakers with expertise in these areas are brought in to conduct different activities and reflection exercises with the students.

All students enrolled in the courses are considered participants, but they can choose not to take part in the quantitative and qualitative assessments. To encourage participation, extra credit in each respective course, fall and spring, is given for completing the assessments for this study. In fall 2022 we had 255 students enrolled in the first course and in Spring 2023 we had 204 students enrolled in the second course.

Quantitative & Qualitative Assessments: Each semester quantitative surveys are given in the form of a pre- and post- survey that incorporates positive psychology through the PERMA (Positivity Engagement Relationships Meaning Accomplishment) profiler [1] and measures student self-efficacy. The two-course sequence are engineering courses with instructional focus on problem-solving thus the research team adapted the Motivations and Attitudes in Engineering: Problem-Solving Self-Efficacy survey (Appendix B) [2] for our use, specifically questions pertaining to course expectancy for the current engineering course they are enrolled in (#1-3, 5-6, and 8-12) and the problem-solving self-efficacy questions (#35-58). The pre-survey is given after the first exam in each course, usually week 5 or 6 in the semester, and the post-survey in the last week of the course after the third exam.

In the spring semester, qualitative data was collected as focus groups at the end of the semester. The focus groups were conducted with approximately 10 students per group and asked questions centered around the following topics:

1) What structure and features of the course have helped students build confidence (self-efficacy) in their ability to solve problems related to physics and engineering?
2) Are there features of this course they would want to see incorporated or stressed more in their other courses?
3) Are there things other courses are doing that we could incorporate into the (names blinded) courses?
4) The success strategies students most often employ when solving problems. How beneficial the wellness and success topics are to them?
    a) Which have they found most useful?
    b) Which could be improved?
5) What else would they like to share about the course?

The focus groups were recorded and will be transcribed for analysis.

Data Analysis: For this work, there is an external Student Success Assessment Team (SSAT) that collects and analyzes all data. Currently, all surveys are being analyzed for trends in the data related to self-efficacy, course expectancy, and the PERMA profiler. For each construct, items will be averaged, and this average score will be used for subsequent analysis. This data is currently being analyzed for trends and comparisons made by factors such as sex, race/ethnicity, and first-gen status as well as comparing final grades for each semester and in students' math courses for the year. Qualitative data collected through the focus groups will be transcribed and coded using the PERMA constructs to develop the first coding schema. Once preliminary data analysis is complete, the SSAT will meet with the teaching team to discuss the results and determine necessary changes for data collection in the upcoming assessment cycle for year 2.

Preliminary Results

In fall 2022, we had 147 students complete the first survey, 170 students complete the second survey, and 109 completing both surveys out of the 255 enrolled students. In Spring 2023 we started the semester with 204 students with 121 students completing the first survey, 148 students completing the second survey, and 99 students completing both surveys. Also, at the end of the spring semester we had 64 students participate in focus groups about their experience in the courses and the impact it had on their confidence and well-being.

The key takeaways from the preliminary data analysis fall into four categories: success factors, the PERMA profiler, problem-solving self-efficacy, and focus group feedback. When looking at success factors, students are equally willing to interact with both instructors and peers and consider the class expectations to be clear, though female students were more likely to discuss course assignments with peers than male students. The students are also aware of the resources the course provides and are willing to use them. From the PERMA profiler, the only score to increase from pre to post was Engagement. All other PERMA scores declined by approximately half a point. Regarding problem-solving self-efficacy, pre and post scores were not correlated with final grades and overall declined from pre to post. The post scores had much more variation compared to the pre scores. Lastly, the focus group participants identified that the structure and features of the course have helped students build confidence (self-efficacy) in their ability to solve problems. However, the success strategies offered in the course need to be better incorporated and reinforced throughout the semester.

As the enrollment numbers show, not all students progress from the first course to the second. There are two reasons for this: students are concurrently enrolled in a two-course math sequence that gets them through pre-calculus and calculus I by the end of the year. Passing the first math course is a prerequisite for enrollment in our second course, reducing enrollment for the second year. Other students choose to change majors or leave the institution between semesters one and two. These correlations are being considered with the quantitative and qualitative assessments we are conducting for this work.

Future Work

This two-course sequence integrates topics across physics concepts and problem solving with computational skills such as data analysis and programming that are organized into separate courses for calculus-ready students. The integration of these two courses presents both opportunities and challenges related to student success. There is some evidence to suggest that the integration of these skills mutually motivate and support one another while on the other hand bringing computational skills into the same course as pre-requisite physics concepts may add more stress to an already "at-risk" population. We plan to analyze the effects of this conceptual coupling with student well-being and self-efficacy in a later phase of this study.

References

[1] J. Butler and M. L. Kern, “The PERMA-Profiler: A brief multidimensional measure of flourishing,” Int. J. Wellbeing, vol. 6, no. 3, pp. 1–48, 2016, doi: 10.5502/ijw.v6i3.526.

[2] A. N. Kirn, “The influences of engineering student motivation on short-term tasks and long-term goals,” 2014.