

Mechanics in Rome: First Time for a New Study Abroad Program

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Brian Self obtained his B.S. and M.S. degrees in Engineering Mechanics from Virginia Tech, and his Ph.D. in Bioengineering from the University of Utah. He worked in the Air Force Research Laboratories before teaching at the U.S. Air Force Academy for seven years. In 2011-12, Brian did a professor exchange in Munich, and in 2017 an exchange in Karlsruhe Germany. Additionally, he established a Mechanics in Rome study abroad program that ran for the first time in Fall 2022.

Mechanics in Rome: First Time for a New Study Abroad Program

Study abroad experiences have been shown to increase cross-cultural sensitivity, improve problem-solving and communication skills, and student's ability to work in diverse teams [1]-[4]. At Cal Poly, we had our inaugural Mechanics in Rome program in Fall 2022. Twenty students from a variety of engineering majors took statics, dynamics, and strength of materials (all three-unit courses) while living together in the Trastevere region of Rome. In this Work-in-Progress paper, I seek to describe our quarter abroad, provide tips on how others could establish a similar program, and also hope to get recommendations from others on how to improve the student (and perhaps instructor!) experience.

Student Pool

Cal Poly is a public polytechnic state university that is on the quarter system. We have over 4000 engineering majors, with approximately 1200 admitted each year. The program was designed to have degree-applicable units that would count for the following majors: Mechanical, Aerospace, Biomedical, Civil and Environmental, Industrial and Manufacturing, Materials, and General Engineering. For most of these majors, the courses need to be taken in their second year to keep students on track for following courses. Industrial and Materials Engineers can count the courses as electives, so they were able to do the program in later years. This meant we could pull from a pool of approximately 1000 students. More details on the academic program are provided below.

Service Provider

It is essential to have a strong service provider to handle all of the logistics and in-country excursions. We used Academic Initiatives Abroad (AIA, <https://aia-study.com/>), a local Rome agency that was founded by two former Cal Poly instructors. After starting a study abroad program in Rome for architects, the founders of the company decided to offer their services to a variety of schools across the United States. AIA also teaches a course in Italian Language and Culture, which counts as a four-unit general education course for our students. This brings the total units that our students earn to 13.

AIA provided a number of invaluable services, including finding student and faculty housing, equipping the classroom, and planning excursions to local sites in Rome as well as two larger excursions to Florence and to Venice. This allowed the professor (namely me) to concentrate on the academics of the program and not which trains to book, how to get museum tickets, arrange bus drivers, or how to arrange for different tour guides. The AIA staff were extremely friendly to both students and faculty, and provided invaluable insights into individual travel planning, Italian culture, and great local restaurants.

Recruitment

Even though we had a potential pool of nearly 1000 students, we only had 14 applicants when we tried to run the program in 2021. We attribute this in large part to residual COVID anxiety, plus I was just getting started with learning how to best recruit for the program. The second year,

we targeted many of the same recruitment avenues, but expanded our efforts as well. All of departments offer some type of first year seminar, and these instructors were contacted and asked to advertise the program. We supplied a sample email they could send out, as well as a slide or two in case they wanted to make an announcement in class. Additionally, we asked all of the department chairs to include an announcement in department emails that are routinely sent out to their students.

I also identified physics instructors teaching the introductory sequence and asked them to advertise the program. Because I attended some physics courses as part of another project, I was able to make some in-person recruitment pitches. Additionally, our Associate Dean emailed all of the first-year students the announcement, and our International Program Center regularly advertises the program and along with other study abroad opportunities.

These different colleagues shared details about the program, provided my contact information, and advertised our different information sessions. Most of these were done over Zoom, but we held an in-person meeting in early March. We invited the students from the inaugural program to attend as well so they can chat with the interested students. As an extra incentive we had pizza (Roman style!) for attendees. Past program participants enjoyed getting to see one another again, and potential applicants seemed to appreciate having program “veterans” there to talk to. For the Fall 2023 program, we received 39 applicants and had to unfortunately turn away 15 students.

Academic Program

Because statics is a pre-requisite for both dynamics and strength of materials (SoM), the courses were taken in a compressed schedule. During the first 4½ weeks, students took 90 minutes of Statics and 90 minutes of the Italian Language and Culture class every day. During the first week, courses were held all five days. The next week there were no classes on Friday, giving the students the opportunity to do individual travel or to explore Rome more extensively. Following another five-day week, we had a shortened week and travelled to Florence with side trips to Pisa, Vinci (Leonardo’s hometown), and the Piaggi Museum. After three more days of class and review, we had our final exam. This resulted in 19 days of 90 minutes for a total of 1710 minutes – as compared to 30 days of 50 minutes of class for a total of 1500 minutes during our regular quarters at home.

After a day of rest, we started up again with dynamics and with strength of materials. At Cal Poly, strength of materials is run as two lectures and one activity period, the latter of which lasts for



110 minutes. As a result, the face-to-face time at Cal Poly totals $50 \times 2 + 100$ minutes $\times 10$ weeks = 2100 minutes each quarter, which is 600 minutes more than dynamics. The activity period in strength of materials is meant to involve more student work and not instructor lecturing. During the second half of the program, the Italian Language and Culture class was reduced to one hour three times per week. Front loading the course also made sense so that the students could learn the language more quickly, then practice their skills more in the later parts of the program. During this second part of the program, we met for 24 different sessions. The SoM course lasted 90 minutes each day, for a total of 2160 minutes. On days where we had Italian class, Dynamics met for 60 minutes; on non-Italian days, for 90 minutes. Total face-to-face time for classes in Rome was equivalent to that of classes in residence at Cal Poly.

Daily Structure

All of the classes were run in a flipped style, where students were responsible for looking at course material before coming to class. For Statics and Dynamics, this was done both by instructor videos and through LearnSmart, McGraw Hill's online system for checking reading comprehension. During class, students worked on concept questions and problems in instructor-assigned teams, coupled with direct instruction. After class, two or three homework problems were assigned using McGraw Hill Connect. Students were given unlimited attempts (numbers in the problem statement were changed for each attempt), and they were able to see the solutions after each attempt to get immediate feedback.

Having studied the material through flipped content, then during class, and finally by completing homework, students were then given a daily assessment at the beginning of each class. The daily assessment was a way to test their problem-solving processes and for them to determine how well they understood the material. Often, a concept question was also included on the assessment. Some days these were team assessments, other days individual; I did not tell them beforehand which one it would be.

At Cal Poly, the Civil Engineering Department teaches SoM, so I used their materials when teaching the course. They have lecture videos for each of 10 modules, and students were instructed to watch these before class. There were also approximately 10 worked out video solutions to problems on the class website, and I instructed students to watch specific problems so we could discuss them in class. There was no homework assigned in the SoM class, but we did still have the daily assessments.

In terms of workload, I asked the students "Recognizing that you are supposed to put in 2-3 hours outside of class for every hour in class, the workload in statics/dynamics/SoM (check all that apply) was ..." Student responses are shown in Fig. 1.

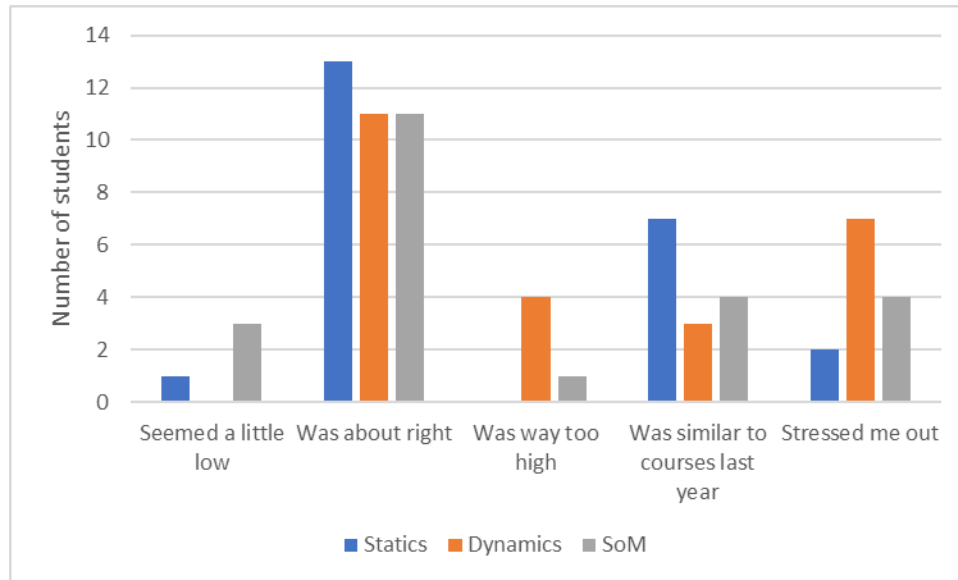


Figure 1. Student responses to “Recognizing that you are supposed to put in 2-3 hours outside of class for every hour in class, the workload in statics/dynamics/SoM (check all that apply)”

Missed Opportunities

I had intended to use many more examples from Ancient Rome in the classes. We went to three different Leonardo da Vinci museums, plus several other scientific museums during our excursions. Although I talked about several models, I didn’t really incorporate a full analysis of them into any of the classes. In future programs, I would like to have student teams choose a Leonardo da Vinci drawing [6] and perform a full analysis on it. There are a number of other Roman structures and accomplishments in mechanics that I could more fully incorporate in the class as well, including military machines, cranes and ramps for lifting huge stones, arches, and domes.



Figure 2. Models in the Leonardo da Vinci museum.

Any other ideas or resources for how to better incorporate Roman and Italian examples of mechanics would be most welcome. When asked “What ideas do you have for more fully incorporating Roman and Italian inventions, science, and engineering into the class?”, students responded:

Make some models like the ones we used in class this year, but with a Roman theme. Like a crane or something

I think the helpful thing about the real world roman examples is just getting your wheels turning about how engineering is all around you

It could be cool to include a little bit of history or fun facts about the invention so we know a bit more about the past of Rome as we are not taking a history class.

I think the visits to museums and the aqueducts were good educational ways to connect dynamics to Rome. When we went on tours, I caught myself thinking about things we were learning in class and applying them to whatever da Vinci models or Roman ruins we were looking at

I could have also done a better job at making linkages between the different classes, particularly dynamics and SoM. We had a catapult project at the end, where I had students determine the stress at a point in the catapult arm as it was accelerating through the swing. Students had to do a cut, or section, FBD as well as a section kinetic diagram to analysis the stresses that were occurring due to the accelerations involved. We also talked about the similarities between area and mass moments of inertia, but I could have stressed this more. The next time I offer the program I plan to have the students develop concept maps of the entire mechanics sequence.

Conclusions

Overall, the program was a huge success for me and for the students. When asked on a Likert scale if “I would recommend this program to my friends,” 16 students strongly agreed and 4 agreed. The group really got along well and formed friendships that will last a lifetime. Students formed a really close-knit learning community, helping one another with homework problems and conceptual difficulties. In future programs, I will try to incorporate more of the evidence-based practices in Learning Communities [7]. Anecdotally, they seemed to perform really well compared to my normal classes at home. Some of this could be due to the different pastries I brought in during the middle of the final exam, but I truly think the primary reason was how much they worked together to learn the material. Having to focus on just two or three subject areas may have also helped, and there was also a minimum 2.5 requirement to get into the program.

The experience for me was also fantastic – I got to know a small group of students really well, and started off every morning with a walk along the Tiber river. We were able to take short day trips around Rome, and my wife and I of course went on the excursions to Florence and Venice along with the students. Although the program can certainly be improved in subsequent years, I will always remember this inaugural group of students fondly.

References

- [1] Coker, J. S., Heiser, E., and Taylor, L., “Student outcomes associated with short- term and semester study abroad programs. Frontiers,” *The Interdisciplinary Journal of Study Abroad*, 30(2), pp. 92-105, 2018.
- [2] Hsu, T.-C., “Intercultural competency development through a study abroad program,” *International Journal of Research Studies in Language Learning*, 3(3), pp. 73-88, 2014.
- [3] Ingraham, E. C., and Peterson, D. L., “Assessing the impact of study abroad on student learning at Michigan State University,” *Frontiers: The Interdisciplinary Journal of Study Abroad*, 10, pp. 83-100, 2004.
- [4] Paige, R. M. and Berg, M. V., “Why students are and are not learning abroad. A review of recent research,” in *Student learning abroad. What students are learning, what they’re not, and what we can do about it*, M. V. Berg, R. M. Paige, & K. H. Lou, Eds., Sterling, VA: Stylus, 2012, pp. 29-58..
- [5] Root, E. and Ngampornchai, A. (2013). “I came back as a new human being”: Student descriptions of intercultural competence acquired through education abroad experiences. *Journal of Studies in International Education*, 17(5), pp. 513-532, 2013.
- [6] Tosone, A. and Frost, C., *Leonardo da Vinci: The complete works*, London: David & Charles, 2006.
- [7] Inkelas, K, et al., *Living-learning communities that work: A research-based model for design, delivery, and assessment*. Stylus Publishing, LLC, 2018.