Turning STEM Education Inside-Out: Teaching and Learning Inside Prisons

JO HARDIN
Pomona College

KARL HAUSHALTER
Harvey Mudd College

DARRYL YONG
Harvey Mudd College

Abstract

The Inside-Out Prison Exchange Program is an international network of teachers and learners who work to break down walls of division by facilitating dialogue across social differences. In this model, first developed by Lori Pompa at Temple University, campus-based college students (outside students) join incarcerated students (inside students) for a college course that is taught inside a correctional facility. Compared to other disciplines, STEM courses are underrepresented in the Inside-Out program. Here we discuss the unique opportunities of teaching a STEM course inside prison using the Inside-Out approach and how it differs from other models of STEM teaching in prison. Our analysis is based on the experience of three instructors from two liberal arts colleges, who taught Inside-Out courses in statistics, number theory, and biochemistry inside a medium-security state prison for men.

Introduction

For over 20 years, the Inside-Out Prison Exchange Program (https://www.insideoutcenter.org), based at Temple University, has brought campus-based college students together with incarcerated students for semester-long courses held in prisons, jails, and other correctional settings all around the world (Davis and Roswell, 2013). The Inside-Out approach to education is a collaboration between all parties involved, not one in which higher education professors and students go to a carceral organization to "help inmates" out of a sense of volunteerism or charity. The Claremont Colleges Inside-Out program at the California Rehabilitation Center (CRC), a medium-security[1] state prison for men located in Norco, CA, was originally brought to Claremont by Pitzer College (one of the Claremont Colleges). The Claremont Colleges Inside-Out program is run in part by a group of incarcerated men at CRC who are vital members of our "Think Tank."

Although hundreds of Inside-Out courses have been taught nationwide and the outcomes have been extensively studied (Inside-Out Prison Exchange Program, 2020), a very small number of the Inside-Out courses offered to date have been in the fields of mathematics or the natural sciences. In this paper, we explore some of the unique challenges and opportunities of using the Inside-Out approach for STEM classes.

We recognize that there are myriad STEM programs inside carceral institutions. They range from the nationally supported (e.g., NSF INCLUDES Alliance) to the very local (e.g., a program at CRC that allows inmates to earn an AA degree from Norco Community College). At the Claremont Colleges, a group of student volunteers goes into prisons to teach non-credit physics, chemistry, and engineering through the Prison Education Project (http://www.prisoneducationproject.org).

In contrast, here we are addressing the specific case of bringing traditional campus (outside) students into prison, not to be teachers, but to be co-learners alongside incarcerated (inside) students. The simple difference of bringing together inside and outside students (which for us included both male and female students) fundamentally changes the structure of the classroom. Without the co-learning process, both the inside and outside students miss out. As part of the Inside-Out experience, the inside students have an opportunity to learn material to which they do not necessarily have access; but more importantly, the power structure of the learning is dismantled in a setting (a STEM class) where hierarchies typically dominate the space (Martin, 2009). For the outside students, the disruption of the power structure of the STEM classroom can be enlightening. The outside students experience the depth of learning that can happen when ideas come from many different perspectives. In our experience, the impact of the Inside-Out classroom can be transformative for both groups of students, helping them to approach their learning and the world in a more humane way (Peterson, 2019).

Here we present reflections based on three separate courses (math, statistics, and biochemistry) taught by three instructors from two different liberal arts colleges. All three instructors had completed the weeklong Inside-Out Training Institute, and we were all teaching our first class in this format. Each course was a full semester, credit-bearing course for all students, both inside and outside. During the semester, the courses met once per week for up to three hours a week inside the prison. We will talk about each course individually and then integrate our thoughts to offer a synthesis and analysis.

TABLE 1. Inside-Out STEM courses described here. Inside = incarcerated students enrolled in California Rehabilitation Center's college program; Outside = campus-based students from the Claremont Colleges

Semester	Course Code	Title	Enrollment
Fall 2018	BIO/CHEM 187	HIV/AIDS: Science, Society, & Service	12 inside, 11 outside
Fall 2019	MATH 57	Thinking with Data	8 inside, 9 outside
Fall 2019	MATH 48	Introduction to Number Theory	13 inside, 4 outside

1 In California, the level of security of a prison determines the style of housing available in that facility, and people are assigned to prisons based on a complicated formula that is supposed to measure risk of misconduct. CRC is a Level II medium-security prison, meaning that the incarcerated people there live in dormitories instead of cells.

Thinking with Data (Jo Hardin)

Although Math 57 was a statistics class taught at an introductory level, it was not "Introduction to Statistics" as most university campuses conceive it. The learning goals centered around being able to critically evaluate numbers and claims based on data that are presented. The hope was for the students to realize that statistical conclusions are being made around them every day, and that to understand how those conclusions come about is a matter not only of quantitative literacy but also of a larger logical framework.

Each week, the students read from a chapter of a statistics text (Utts, 1999) along with external articles. For example, during the week when we covered sampling, the text was supplemented by articles on the sampling methods suggested by the Census Bureau as a way to improve the accuracy of the census—methods that were ultimately ruled unconstitutional by the Supreme Court, although statisticians believe the outcome of the ruling is to continue to undercount people of color and people with transitional living situations (*Department of Commerce v. U.S. House of Representatives*, 1999). During the week covering probability, we spent time discussing forensics and how different "match" probabilities (e.g., hair match, DNA match, etc.) can have very different accuracy rates.

A typical day started with an activity designed to bring us all into the space, followed up with an activity which would highlight the day's topic. For example, during the week in which we covered confidence intervals, I brought in a blow-up globe. We stood in a circle and threw the ball to one another, each time recording whether our right thumb landed on water or land. We used technical details from the week's readings to calculate a confidence interval for the proportion of the Earth that is covered in water. (Depending on the correctional facility's character, you might not choose to throw a ball around in an Inside-Out class; some facilities have strict security protocols and will not allow anything to be thrown around the classroom.)

After the topic-specific activity, we would often gather in small groups with a list of pre-written discussion questions. The thought questions were meant to help the students dig deeper into the readings and debate the topic at hand. Time and again, both the inside and outside students reported that the group discussions were their favorite part of the class. In their small groups, hesitant students were given a voice, and each student could share their understanding of the material without fear of speaking up incorrectly in front of the entire class.

Although we often ran short on time, we would always close with some kind of reflection on the material or on the day's activities. Sometimes we would go around the circle with a one-word reflection. Sometimes I would ask them to report the part of the day which they were still struggling to wrap their heads around, or, slightly nuanced, the topic which was hardest to understand in general.

After the class session each week, students were asked to write a reflection essay. The reflection essay was among the most powerful aspects of the class, as it gave the students an opportunity to spend time putting down on paper both their emotional reactions and their understanding of the statistical topics. The reflection paper had three sections: (1) observations from the class meeting—anything that stood out, (2) statistical analysis—using references from the texts, and (3) emotional reactions—feelings.

The reflections essays were not given a letter grade, yet they served the incredibly valuable purpose of connecting each and every student to both the material (statistical content) and the people in the room. Detailed instructor feedback was provided on the essays, and without the essays, especially the personal reflection part, it would have been much harder for the students to feel connected and integrated into the course.

The last three weeks of the semester were spent working on projects whose purpose was to bring the ideas from the class into a larger space. Outside visitors were invited to the closing ceremonies, but the logistics surrounding visitors' clearance was unfortunately too complicated. Instead, the students presented their projects to each other. One group did a Dear Data (http://www.dear-data.com/) assignment where they compared artistic visualizations of the data describing a week in an inside student's life with a week in an outside student's life. Another group made a chain link out of construction paper where each link detailed a study, a dataset, or an individual's story describing recidivism. A third group talked about some of the biggest misconceptions in statistical studies and how we can raise our consciousness to form valid conclusions about a study.

HIV/AIDS: Science, Society, & Service (Karl Haushalter)

Chemistry 187 explored scientific and societal perspectives on infectious disease. The course was divided into three modules focusing on plague, HIV-AIDS, and tuberculosis, with time approximately evenly divided between societal context and scientific content. The complex and multidisciplinary challenges of responding to highly stigmatized infectious diseases such as HIV-AIDS can be fertile ground for exploring the entanglement of science and society, as demonstrated by the large number of published courses that use HIV-AIDS as a focus for integrating science education and civic engagement (for example, see Fan, Conner, & Villarreal, 2014; Iimoto 2005; SENCER 2020a; SENCER 2020b).

Chemistry 187 was taught with the Inside-Out pedagogy, which emphasizes a dialogic approach with the majority of class time spent in small, mixed discussion groups (Pompa, Crabbe, & Turenne, 2018). For the Chemistry 187 content related to our societal readings, this format was a natural fit for the issues we examined. The students learned substantially from each other, especially given their differing perspectives based on life experiences related to the social determinants of health, which was an underlying theme of the course.

Implementing the Inside-Out pedagogy for the science content of Chemistry 187 was challenging for me as an instructor. Many of our chosen topics (e.g., virology) required a firm understanding of threshold concepts (e.g., the central dogma of molecular biology) in order to have an entry point into meaningful discussions (Meyer and Land, 2003). As an instructor, I felt that I could not ignore the variation in previous exposure to biology instruction, but I did not want to center upon this difference either. Thus, even though the students majoring in biology could have taught lessons on the threshold concepts, this approach would be counter to the spirit of Inside-Out in which the students are all co-learners. Ultimately, I used a hybrid approach that featured some mini-lectures that I strived to make as interactive as possible. When possible, these mini-lectures were preceded by small-group brainstorming sessions to generate motivating questions for the mini-lectures and followed by small-group applied problem-solving sessions. The Inside-Out emphasis on community building, through icebreakers, circle activities, and jointly authored ground rules, paid dividends in the smooth functioning of the small group science lessons.

If Chemistry 187 were taught as a traditional college campus-based course, the class would utilize technology (lecture slides, PyMOL, YouTube animations) for visualizing the molecular details of host-pathogen interactions. In prison, where it was not possible to routinely access this type of technology, our class had to develop other methods to help the unseeable be seen. Indeed, the absence of technology led to creative solutions. By providing the students with large-format flip chart paper and thick colored markers, I allowed them to be creative in making colorful, detailed images that were even more informative than the standard slides used in the traditional campus-based course. Several of the students had untapped artistic talent and working together with their classmates to interpret our readings, they were able as a group to communicate complex scientific ideas visually on the flip chart paper.

An important part of an Inside-Out course is the end-of-semester group project. These projects are intended to be focused specifically on intersections of the course disciplinary topic and prison, with a strong emphasis on application (Pompa, Crabbe, & Turenne, 2018, p. 55). In Chemistry 187, teams were blended, with two or three inside students and two or three outside students in each team. All students were tasked to bring their own expertise to bear on the project, the theme of which was picked by the student teams. For example, one of the student teams created educational posters about influenza vaccination. As a class, we learned from the inside students that the flu vaccine is available at the California Rehabilitation Center, but many incarcerated men do not opt to get vaccinated, possibly due to low trust in the prison health system and widespread conspiracy theories (e.g., prison officials used the flu vaccine to inject people with tracking devices). This is a missed opportunity to prevent a serious communicable disease that spreads easily in confined spaces (Sequera, Valencia, García-Basteiro, Marco, & Bayas, 2015). Working together, the inside and outside students on this team developed materials to address the common concerns of the target audience related to influenza vaccination and provide health-promoting education in the context of prison.

Other team projects included a letter to the warden proposing the adoption of harm reduction strategies (e.g. bleaching stations for sterilizing needles used for illicit tattoos or injection drug use) to reduce the spread of hepatitis C in prison; educational pamphlets about preventing sexually transmitted diseases; and an evidence-based letter to the State Prison Board about the connection between nutrition and a healthy immune system. The student projects shared in common the key feature of bringing together inside and outside students to share their unique expertise as they collaborated on a project that applied what they had learned about the science of infectious disease during the semester to an authentic issue in the living context of the inside students.

Introduction to Number Theory (Darryl Yong)

Even though I have no formal training in number theory, I chose to teach this subject because it lends itself well to exploration and rehumanizing approaches to teaching and learning mathematics (Goffney, Gutiérrez, & Boston, 2018). Requiring only some mathematics skills and ideas from high school algebra, this course started with the divisors of integers and modular arithmetic and culminated with the Rivest–Shamir–Adleman (RSA) cryptosystem, a widely used method for secure data transmission.

Of our three courses, this one was perhaps the most grounded in its disciplinary content. While I organized several class discussions around our prior experiences of learning mathematics and about contemporary mathematicians (mostly of color), about 90% of class time was spent working on carefully sequenced sets of mathematical tasks in small groups. Students shared their results communally on the board, and I occasionally convened the group to share their findings with each other. The list of tasks for each class was adjusted based on what students accomplished and found interesting in previous classes.

In "Math Instructors' Critical Reflections on Teaching in Prison," Robert Scott writes: "A math pedagogy premised upon following the rules, accepting that there is only one right answer, and relying on practice/repetition in order to habituate oneself to predetermined axioms would seem to reprise the culture of incarceration itself." How does one teach a class on a well-established field like number theory without reproducing the dehumanizing effects of prisons in the classroom?

To do this, I used a pedagogical approach based on my work delivering professional development to secondary school teachers through the Park City Mathematics Institute. In this approach, students encounter new mathematical ideas without any formal definitions or specialized notation. The mathematical tasks are designed to encourage students to look for patterns and make connections. Mathematical ideas are solidified when students give voice to them by sharing them publicly. Finally, after several exposures to similar patterns and connections, I formalized ideas by introducing their established mathematical names and notations. I followed this general approach during the entire course except for the last day of class when we used all of the machinery that we had developed to explain how the RSA cryptosystem works (Omar, 2017). So, even though students were often practicing and repeating mathematical calculations, they were in fact creating meaning for themselves and others in the classroom.

My observations of the students' progress and their written reflections lead me to believe that they truly enjoyed learning mathematics, even though some had been traumatized by previous mathematics learning experiences. Each class period seemed to fly by. Students would work almost continuously for the entire period, though there was also quite a bit of casual banter and joyful laughter around the room. It felt like a space where both inside and outside students were doing mathematics and creating meaning together. My Inside-Out experience made me wonder why I don't try to use more of this kind of rehumanizing pedagogy in my usual classes at Harvey Mudd College.

Lessons Learned

Examining the experiences of the three instructors, we find that several common themes emerge from our efforts to integrate STEM content within the Inside-Out Prison Exchange program. First, while many undergraduate STEM courses are primarily lecture-based, the Inside-Out program challenges faculty to use liberatory pedagogies (Freire, 1970). Thus, we all chose to minimize lecturing as much as possible and spend most of our class time in small group activities or whole class discussion. These forms of instruction democratize intellectual authority in the classroom and allow both inside and outside students to draw on personal funds of knowledge. An inside student wrote, "In non-Inside-Out classes I don't learn who my peers are, whereas this class was unique in the fact that we were learning from one another just as much as we were learning from our professor." Furthermore, with the inside and outside students constantly talking together and working with each other, the students discovered for themselves the many ways in which traditional college-age STEM students and incarcerated STEM students share common struggles, concerns, and motivations.

A second common theme that we encountered in our classes was how Inside-Out courses helped students uncover and confront societal expectations and stereotypes about who is competent in STEM. In our end-of-course evaluation surveys, we asked students what their biggest worry about the class was prior to starting the course. A few outside students wrote that they were concerned that the Inside-Out course wasn't going to be as rigorous as their usual courses, whereas inside students wrote that they were initially concerned about being able to "keep up" with the outside students. These concerns relate to societal stereotypes that STEM competence is innate rather than a skill to be developed and that incarcerated people and people of color are not able to access STEM. Fortunately, these surveys also revealed that students uniformly felt their Inside-Out courses to be intellectually demanding and that inside students felt successful in the class and were recognized for their contributions in class. The reason that students were able to upend their worries was because our Inside-Out courses brought together groups of people who would otherwise never get to meet each other in the context of doing rigorous, challenging STEM work together. One inside student wrote that he was surprised at the "ease [with] which people from diverse lifestyles and backgrounds can struggle with a subject, work together, and succeed."

Finally, all three of the authors chose to teach an Inside-Out course primarily because of the humanity it offered to our work. And while none of us are experts in criminal justice, we are all deeply aware that STEM is neither objective nor apolitical. When designing our courses, we specifically chose topics and approaches that would connect STEM back to the human condition, for example, discussing how disease manifests in different communities, how forensic probabilities do not represent truth, and how mathematical self-identification is different from mathematical ability. There is abundant evidence that bringing humanity into STEM can have an enormous impact on marginalized communities, and we believe that our courses are part of that trend.

Along with humanizing the course content in each of our STEM courses, the act of bringing the courses inside is a manifestation of our collective belief that STEM is not the domain of the privileged few. Instead, science and science education belong to and are in service of all people. In plain sight of each other, students of all backgrounds are able to embrace the learning of STEM content. Creating a space that allows for the tangible recognition by everyone involved that STEM is for all people is itself a highly political act.

Acknowledgements

We are grateful for the guidance and support of our colleagues from the Claremont Critical Justice Education Initiative, especially Tyee Griffith, Tessa Hicks Peterson, Gabriela Gamiz, and Nigel Boyle. We would like to thank the staff at the California Rehabilitation Center for their continuing partnership. Financial support was generously provided by the Andrew W. Mellon Foundation and the Academic Deans Council of the Claremont Colleges. Critical feedback on the manuscript was provided by Tessa Hicks Peterson and David Vosburg. We gratefully acknowledge Lori Pompa and the Inside-Out Center for their leadership and expertise. Finally, we owe the largest debt of gratitude to our students, both inside and out.

Dedication

This article is dedicated to the memory of David L. Ferguson, whose lifelong work in extending the joys and benefits of STEM education to underserved students continues to inspire us. David saw the potential to be a scholar in all of his students, even before they could see it in themselves. We strive to follow the example of David's pioneering work in diversity and inclusive excellence in STEM education.

Authors

Jo Hardin (*Jo.Hardin@pomona.edu*) is a professor of mathematics at Pomona College. She is a statistician by training, and her research focuses on applied and interdisciplinary projects with molecular biologists. Through the Posse Foundation, she has mentored students at Pomona College originally from Chicago, IL.

Karl Haushalter (*haushalter@hmc.edu*) is an associate professor of chemistry and biology at Harvey Mudd College. His research interests include the enzymology of DNA repair and the regulation of gene expression by small RNA. Karl works closely with the Office of Community Engagement at HMC and has led faculty development workshops to promote community-based learning.

Darryl Yong (*dyong@hmc.edu*) is a professor of mathematics, associate dean for faculty development and diversity, and mathematics clinic program director at Harvey Mudd College. He was also the founding director of the Claremont Colleges Center for Teaching and Learning. His scholarship has several foci: the retention and professional development of secondary school mathematics teachers, effective teaching practices in undergraduate STEM education, and equity, justice, and diversity in higher education.

References

Davis, S., & Roswell, B. (Eds.). (2013). *Turning teaching inside out: A pedagogy of transformation for community-based education*. New York, NY: Springer.

Department of Commerce v. United States House of Representatives, 525 U.S. 316 (1999).

Fan, H. Y., Conner, R. F., & Villarreal, L. P. (2014). *AIDS: Science and society* (7th ed.). Burlington, MA: Jones & Bartlett Learning.

Freire, P. (1970). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). New York, NY: Continuum.

Goffney, I., Gutiérrez, R., & Boston, M. (Eds.). (2018). *Rehumanizing mathematics for Black, Indigenous, and Latinx students*. Reston, VA: National Council of Teachers of Mathematics.

Iimoto, D. (2005). AIDS and other human diseases: Teaching science in the context of culture. *Journal of College Science Teaching, 34*, 38–41.

Inside-Out Prison Exchange Program. (2020). *Scholarship on Inside-Out*. Retrieved from https://www.insideoutcenter.org/scholarship-inside-out.html

Martin, D. B. (2009). Researching race in mathematics education. *Teachers College Record, 111*(2), 295–338.

Meyer J. H. F., & Land, R. (2003). Threshold concepts and troublesome knowledge. In C. Rust, (Ed.), *Improving student learning—ten years on* (pp. 412–424). Oxford, UK: Oxford Centre for Staff and Learning Development.

National Science Foundation (NSF). (2019). *NSF INCLUDES Alliance: STEM opportunities in prison settings*. Retrieved from https://www.nsf.gov/awardsearch/showAward?AWD_ID=1931045)

Omar, M. (2017). *Number theory toward RSA cryptography: In 10 undergraduate lectures*. (n.p.): CreateSpace Publishing.

Peterson, T. H. (2019). Healing pedagogy from the inside out: The paradox of liberatory education in prison. In R. Ginsburg (Ed.), *Critical perspectives on teaching in prison: Students and instructors on pedagogy behind the wall* (pp. 175–187). New York, NY: Routledge.

Pompa, L., Crabbe, M., & Turenne, E. (2018). *The Inside-Out Prison Exchange Program instructor's manual*. Philadelphia, PA: The Inside-Out Center, Temple University.

Scott, R. (2019). Math instructors' critical reflections on teaching in prison. In H. Rosario (Ed.), *Mathematical outreach: Explorations in social justice around the globe* (pp. 211–232). Hackensack, NJ: World Scientific.

SENCER (Science Education for New Civic Engagements and Responsibilities). (2020a).

Backgrounders. Retrieved from http://sencer.net/backgrounders/

SENCER (Science Education for New Civic Engagements and Responsibilities). (2020b). *Model courses*. Retrieved from http://sencer.net/model-courses/

Sequera V. G., Valencia, S., García-Basteiro, A. L., Marco, A., & Bayas, J. M. (2015). Vaccinations in prisons: A shot in the arm for community health. *Human Vaccines & Immunotherapeutics, 11*(11), 2615–2626. doi:10.1080/21645515.2015.1051269

Utts, J. (1999). *Seeing through statistics* (2nd ed.). Pacific Grove, CA: Duxbury Press.