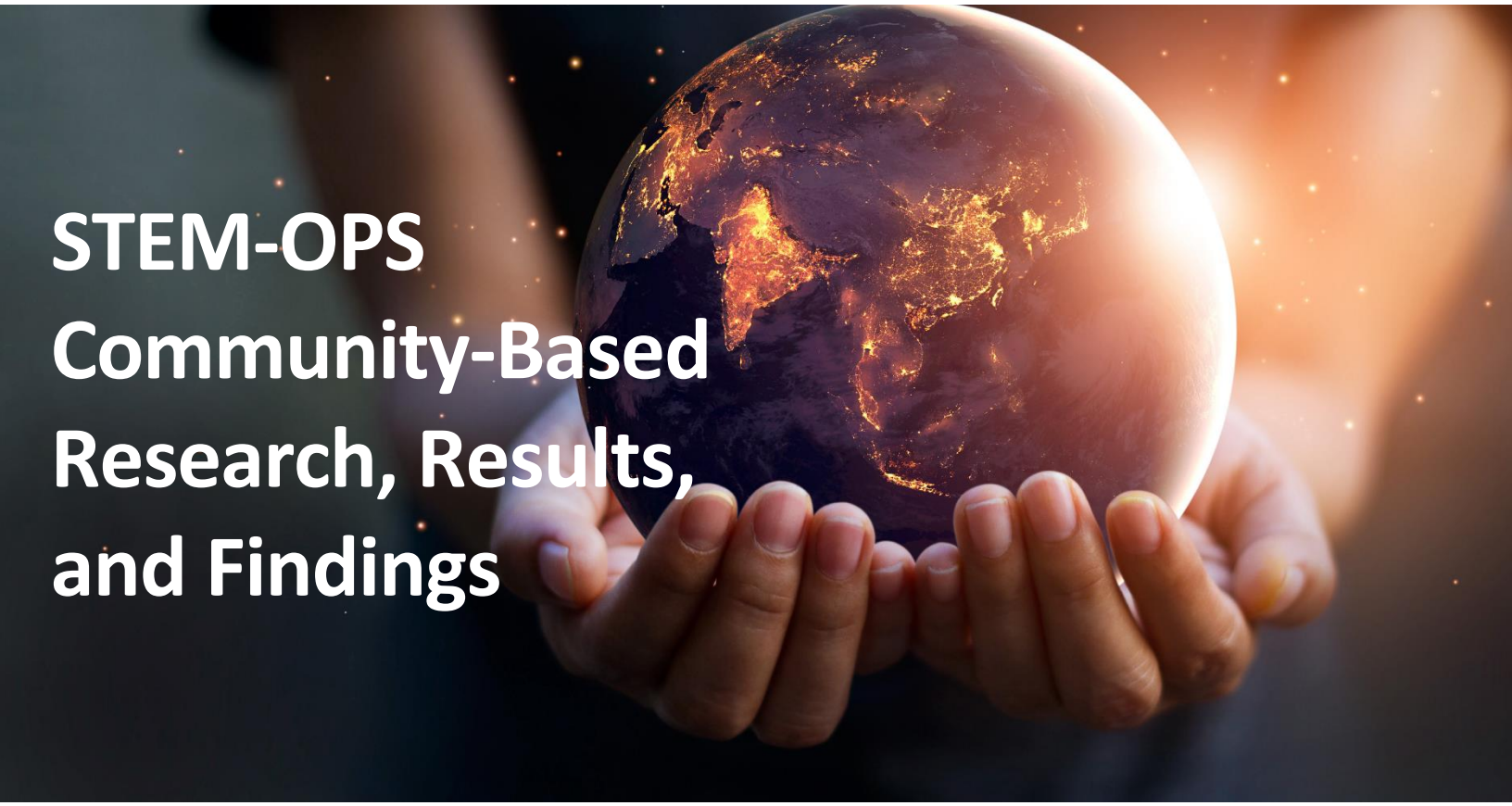

STEM-OPS Community-Based Research, Results, and Findings

EDC.ORG

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STEM-OPS Community-based Research, Results, and Findings

People closest to the problem are closest to the solution, but furthest from power and resources. (Glenn E. Martin)

In an effort to change this typical imbalance between proximity to solutions and to power and resources, we of the National Science Foundation's Eddie Bernice Johnson INCLUDES Alliance STEM Opportunities in Prison Settings (STEM-OPS) program engaged in community-based research throughout the project to highlight the expertise of those closest to the problem (and the solution); to increase their autonomy (power and voice); and to build support networks around such problems and solutions. In this way, the research of STEM-OPS supported broadening participation. The National Science Foundation recognizes the critical need to broaden participation in STEM+C fields and funded STEM-OPS.

The creative engagement of diverse ideas and perspectives is essential to enabling the transformative research that invigorates our nation's scientific and engineering enterprise. Broadening participation infuses science and engineering excellence into varied individual, institutional, and geographic networks and provides for the discovery and nurturing of talent wherever it may be found.
(NSF Executive Summary Report to Broadening Participation at the National Science Foundation: A Framework for Action – 2008)

STEM-OPS has been working to impact the system of science, technology, engineering, and mathematics (STEM) by radically shifting learning opportunities in prisons and access to STEM (broadly defined) for those who are directly impacted by the carceral system.

All persons impacted by the carceral system are able, and encouraged, to pursue a culturally responsive and equitable high-quality STEM education and career. (STEM-OPS Vision)

The STEM-OPS research team and participating community produced a variety of results and findings that informed the STEM-OPS Working Group products—a series of toolkits available for public use. Based on the premise that the voice of directly impacted people should be centered in the research, we managed a series of community-based research projects rooted in our broader STEM-OPS network, with an emphasis on the direct involvement and leadership of formerly incarcerated people. Below, we highlight various datasets, results, and findings from this work, including the use of single-use surveys, ongoing Affinity Groups, short-term cohorts of community members, and collaborative analysis.

Part 1
Survey and Affinity Groups

STEM-OPS Survey

We launched our first community-focused research in spring 2020 using a Qualtrics survey with only one open-ended question, "Why is it so difficult for people who were incarcerated to have successful STEM careers?" We wanted to hear from a broad range of people, both with and without knowledge of the carceral system, because both narrative and experience perpetuate that system. We wanted to hear in people's own words what they saw as the main obstacles to formerly incarcerated people gaining a STEM education and career. The survey was disseminated through STEM-OPS partners as well as by their extended networks and Education Development Center (EDC), and reached 11 states, 30 key partnerships, and 200 prospective partners.

Why is it so difficult for people who were incarcerated to have successful STEM careers?

Our goal was to continue to seek survey responses until we reached a point of saturation, when new responses stopped providing new information or ideas related to the question. In June 2020, with over 500 respondents, our survey ceased to bring in new ideas. The research team developed a codebook based on a review of relevant literature on education in prisons and STEM opportunities for people impacted by incarceration, and updated this codebook as we learned from the survey responses. The team conducted coding and mixed methods analysis using the qualitative analysis software, MAXQDA.

Survey Findings

The process of coding responses resulted in a list of 22 overlapping obstacles to STEM education and career development pre-, during, and post-incarceration.

- About 75% of respondents self-assessed their level of experience with (1) STEM and (2) the carceral system, relative to *the general public*. Almost half of our participants, 238, self-identified as having **more** or **significantly more** experience than the general public with STEM, while about 40%, 205 participants, felt they had **more** or **significantly more** experience with the carceral system. This suggests that we also had strong participation from those who felt they had about the same experience as the general public. The lowest participation numbers were from those who identified as having either **less STEM experience** or **less experience with the carceral system** than the general population. These numbers are not surprising, given the dissemination strategy focused on networks involved in both STEM and incarceration, and reflects that many respondents had direct experience with the elements of the system we are mapping.
- From a review of literature, we initially developed 20 codes. Over the course of our analysis, the system grew to 25 codes as more were added that emerged from the survey responses; ultimately, three codes were removed. The most frequently used codes related to systemic factors that

influence access to STEM education and careers in prison, including “Prejudice/Stigma/Bias,” “Laws and Policies,” “Higher Education Quality of Programming,” and “STEM Disciplines.”

- We employed a cross-coding heuristic to identify relationships within the system by analyzing the frequency with which codes appeared together. In this process of cross-coding, inter-relationships dominated responses. Direct relationships between pairs of codes were visualized using chord and tree diagrams (see Figure 1). For example, when we considered the role of STEM disciplines in the challenges to access, “STEM Disciplines” was strongly related to codes such as “Dominant Narratives,” “Disenfranchisement,” and “Higher Ed Program Resources.”

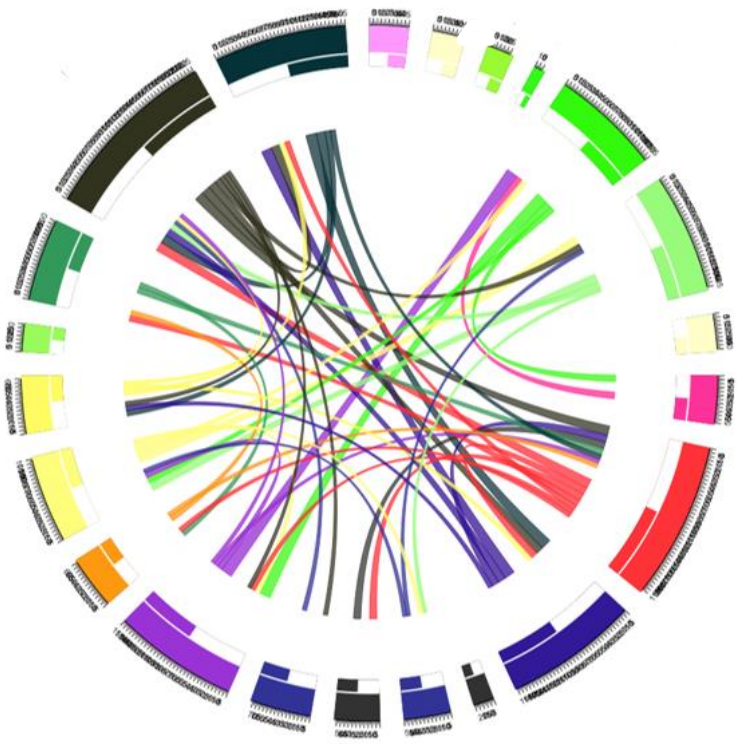


Figure 1. A Complex Web of Obstacles

Note: *In addition to highlighting the paired relationships, the chord visualization further highlights the interconnectedness of the obstacles. The visualization suggests a powerfully complex system at work, making it so difficult for directly impacted people to have successful STEM careers.*

As we expanded beyond paired relationships to trio- and quad- relationships (and beyond), we began to see glimpses of systems in action. For example, a significant nexus of systemic relationships was identified around “STEM Disciplines”: “Higher Ed Quality of Programming,” “Higher Ed Program Resources,” and “Systemic Lack of Access to Education and Careers in Prison.” Another strong nexus of relationships revolved around “Prior Educational Experiences.” Five codes regularly co-occurred together with this code: “Systemic Lack of Access to Education and Careers in Prison,” “Higher Ed Quality of Programming,” “Disenfranchisement,” “STEM Disciplines,” and “Prejudice/Stigma/Bias.”

STEM-OPS AFFINITY GROUPS

In the first year of the project, STEM-OPS established eight regional and topic-focused Affinity Groups made up of STEM-OPS founding members and partners, as well as members of over 60 other organizations. Each leading partner organization besides EDC (the "Backbone" organization) led two Affinity Groups that met regularly (usually monthly) and followed a similar progression of activities to explore issues within their area of focus. The Backbone supported all Affinity Groups. Each group had four to twelve members from a range of organizations and fields. Each group included at least two members—but typically more—who were previously incarcerated.

List of original Affinity Groups

- Northeast
- Midwest
- Southeast
- West Coast
- Disrupting School to Prison Pipeline
- Data and Measures
- Formerly Incarcerated Women
- Reentry and Mentoring

Each Affinity Group completed a common sequence of meetings, beginning with an exploration of challenges to the mission, developed by STEM-OPS leadership, then moved into making sense of root causes of these challenges. Ultimately, each Affinity Group had the opportunity to select three of their key challenges to raise up to STEM-OPS leadership as essential to address. These challenges, as with those identified in the survey, contributed to the community-focused STEM-OPS strategic plan. Each group also had the opportunity to develop foundational pieces of work on which further work could be built. While all groups had the opportunity to see and discuss survey results, this was not the focus of their work. Instead, we intended for them each to surface the issues that felt relevant to their group.

Findings

Affinity Group meetings continued throughout 2020 and into spring 2021, and concluded with the elevation of three central challenges from each group to achieving the STEM-OPS vision and the identification of stories of success that countered the deficit narratives that sustain current inequities in participation in STEM. These discussions informed STEM-OPS' measures of success, affirmed findings from the earlier survey, and yielded 22 unique challenges to our vision. These challenges to the vision coupled with the earlier obstacles to successful STEM careers began informing the strategy that STEM-OPS would use in Years 3–5.

At the same time as the Affinity Group meetings, following the survey, there was one more important research component to come: community-based system dynamics.

Part 2

Community-Based System Dynamics and the Systems Mapping of STEM-OPS

Community-Based Systems Dynamics (CBSD) is a process which allows communities—with their diverse stakeholders—to take part in building understanding of the systems in which they take part, the foundational element to changing their systems. Through carefully structured activities, stakeholders share stories and experiences that illustrate different variables and relationships that impact the systems in which they live. As with the chord diagram, what begins to emerge is on one hand a system in its complexity, and on the other hand a system that allows for a multiplicity of experiences. This means there is not one "right" experience, thus creating an unparalleled opportunity to build understanding among stakeholders. As the process progresses, diverse stakeholders work to illustrate the system in question by co-constructing maps, or causal loop diagrams, that highlight not only the variables at play but how they interact to drive (and perpetuate) system behavior.

Working with Kelsey Werner of Boston College, we first built a core modeling team that would help facilitate the process. This team included STEM-OPS researchers Eden Badertscher and Una MacDowell, advisor Otis Jennings, and three directly impacted STEM-OPS Affinity Group participants: Veronica Horowitz, Jason O'Malley, and Noel Vest. This process helped us examine and discuss the carceral system through the lens of obstacles to STEM education and careers. Out of this, we were able to begin to build our own series of systems maps. The causal loop diagram in Figure 2 on page six illustrates the overarching STEM-OPS systems map.

Our first systems map was built through the work of two diverse cohorts of 25 people, each from the wider STEM-OPS community and other organizations, in addition to the core modeling team. In CBSD (as referenced in our opening quotation), the people who are most impacted by the system are centered as experts, leading to the best opportunities to change the system. For STEM-OPS, this meant that roughly half the participants were justice-impacted individuals; the remaining individuals represented other stakeholder groups, including department of corrections, higher education in prison programs, reentry service providers, family members, and community members. We also led CBSD workshops at the first STEM-OPS convening to broaden participation and to identify changes in the systems.

The results of this work (see Figure 2 on page six for the top level of the systems map) were integrated with the survey data and Affinity Group findings to inform the final development of the STEM-OPS strategic plan to guide the first 10 years of STEM-OPS, detailed in a strategy map. While we will not go into significant detail relative to that first systems map, we will take a little time to review some key ideas in causal loop diagrams because solution mapping work grew out of the work of the strategic plan, as will be discussed below.

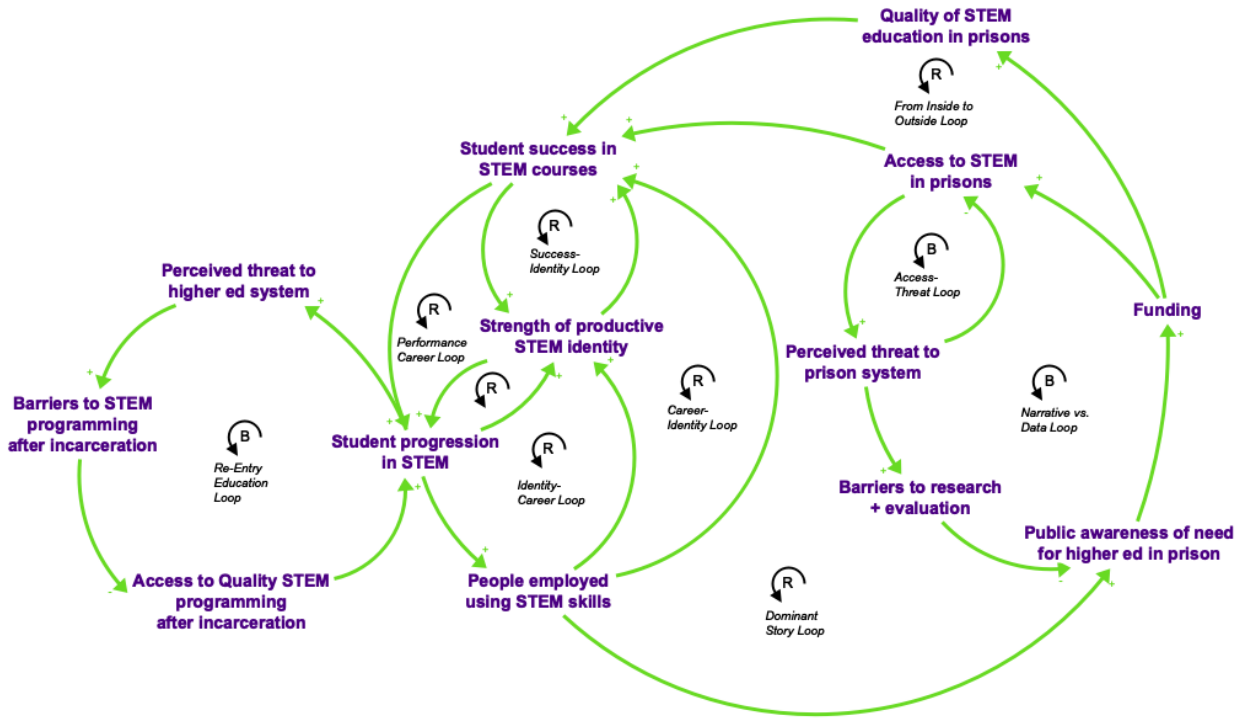


Figure 2. Overarching STEM in Prison Systems Map

CBSD and the STEM-OPS Systems Maps – What Is This Mess?

On first sight, a causal loop diagram might look like chaos; it is difficult to even know where to begin to make sense of it. However, System Dynamics, the science of studying systems, has demonstrated that if we remove complexity from the problem, we remove the very nature that contributes to the challenge. We need to learn to work with and understand system problems in their complexity as a community if we are to solve them. And the carceral system is a complex, messy system! STEM education and careers is also a complex, messy system, with significant exclusion. And STEM-OPS intended to integrate these? This is in fact precisely why we needed to engage in CBSD—so the community itself could come together to understand and build the complex causal loop diagram to position themselves to be able to tackle the system. Once built, such a model or map helps us to think more strategically about how to intervene in the system to achieve our goals.

A causal loop diagram is a visual representation of a system, in this case a visual representation of the carceral system with a focus on gaining STEM education and careers within that system. Such a map results as we uncover drivers of the system and the feedback that enables the system to self-perpetuate. By highlighting how different variables in a system are causally interrelated, we more deeply understand the self-sustaining behaviors and relationships. This allows strategic planning to be more proactive and to prepare for other types of feedback that will likely result, so positive feedback can be maximized and negative feedback constrained.

A Brief Systems Maps Primer

The image below is a causal loop diagram or “systems map” that represents a very simple system at work. Please note, however, that the map represents only a tiny portion of a much larger and more

complex system. We use this simplified causal loop diagram to demonstrate the kind of information contained in these maps.

THE DISCIPLINE–EXCLUSION MAP

This map contains three primary elements. The first element is the **variable**. These are the different things in which we are interested, such as *Quality of STEM Instruction* or *Student Engagement.*

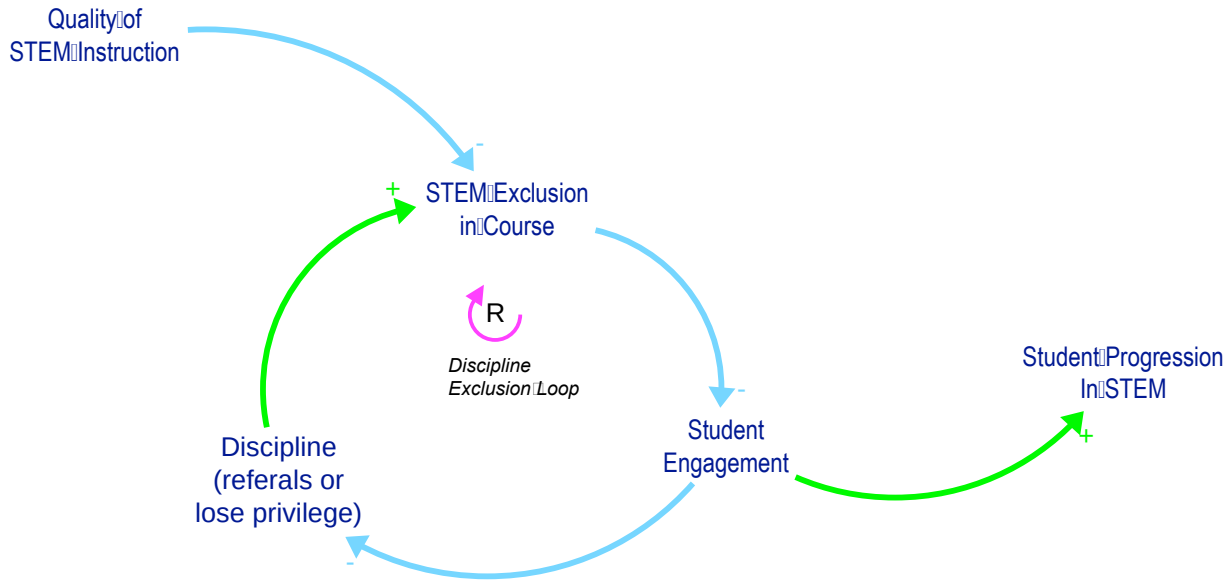


Figure 3. Discipline–Exclusion Map

The second element is the **relationship arrow**; if you look closely, you will notice this arrow has a positive or negative symbol attached to it. The third element is the **loop identifier**; this is the "R" with the looping arrow around it and a loop title below it.

Once we have identified variables, the **relationship arrows** provide two main pieces of information: They help us understand the direction of influence and the nature of that influence. (Please note that, since this is a simplified map, not all arrows are represented.) An arrow with a "**+**" sign, also colored **green**, indicates that that one variable influences the other variable in the **same** way, meaning a decrease will lead to a decrease, or an increase will lead to an increase. An arrow with a "**-**" sign, also colored **blue**, indicates that one variable influences the other variable in the **opposite** way: An increase in one leads to a decrease in the other, or a decrease in one leads to an increase in the other.

Finally, the **loop identifier** tells us how the loop behaves and the direction of the loop. Most of the loops we encounter in our work are *reinforcing loops*, denoted by "R." They are reinforcing because they not only self-sustain, as all systems do, but their impact grows. We often speak about these as either "virtuous" or "vicious" cycles. They get better and better or worse and worse. The good news is that a vicious cycle can become a virtuous cycle when the right set of forces is applied. We have one loop represented above, but when there are many interconnected loops it helps illustrate the complexity and interconnectedness of issues, and it helps us understand why changing one thing in a system often fails to change the system. There is another kind of loop: a balancing loop, denoted by "B." Unlike the reinforcing loop, which continuously improves or worsens, a balancing loop seeks a stable state.

PUTTING IT ALL TOGETHER

What does this simplified systems map show us? Following from the top left, we see that there is a blue "negative" arrow between Quality of STEM Instruction and STEM Exclusion in Course, meaning that as the quality of STEM instruction increases, there will be less STEM exclusion within STEM courses.

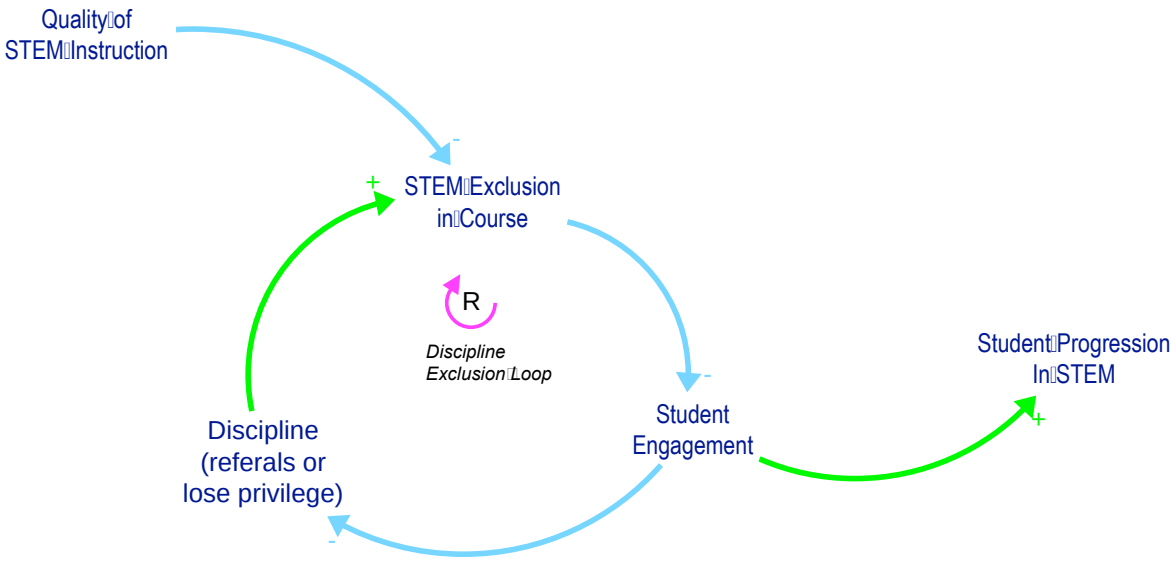


Figure 4. Simplified Discipline–Exclusion Map

Remember, a negative arrow means the variables move in opposite directions, so this could also mean as quality decreases, exclusion increases. As there is less STEM exclusion, the next blue negative arrow indicates there will be an increase in student engagement. The next blue arrow indicates this increase will lead to fewer disciplinary actions, whether in the form of referrals or lost privileges. The green positive arrow indicates that a decrease in disciplinary action will lead to a decrease in STEM exclusion. These three variables maintain the reinforcing loop. We included one more variable to demonstrate this loop can connect to other variables (and hence to other loops). In this case, as student engagement in STEM increases, the green positive arrow indicates that this will produce an increase in student progression through STEM courses. However, once a cycle is in place, there is no beginning or end; you can begin tracing a loop at any point.

The *Discipline–Exclusion Loop* reads as follows:

- As Discipline **goes up**—e.g., teacher sends student out of class (green arrow with a + sign), STEM Exclusion **goes up** because student misses out on teaching/learning opportunity.
- As STEM Exclusion **goes up,** Student Engagement **goes down** (blue arrow with a – sign).
- As Student Engagement **goes down,** Discipline **goes up.**

This continues in a vicious, self-perpetuating cycle. Reinforcing loops can be either vicious or virtuous cycles.

Part 3
STEM-OPS Working Groups – Products and Systems Maps

STEM-OPS Working Groups

The Affinity Groups discussed earlier transitioned into a set of six Working Groups whose focus was to go beyond the work of the Affinity Groups to develop and share solutions to some of the key challenges identified. They did this by creating tools and products that could be broadly implemented. The topic(s) for each Working Group were identified and refined through an iterative process of collaborative reflection and discussion among the Executive Committee, based on a review of (1) the survey finding, (2) Affinity Group findings, and (3) ongoing systems mapping work. The result was a list of Working Group topics that were seen as areas where positive change could lead to increased participation in STEM education and careers by formerly incarcerated people. Each Working Group was formed with a mandate to take on one topic, come to an agreement on a solution, and create a product that could be of practical use towards achieving the STEM-OPS vision.

Like Affinity Groups, the Working Groups consisted of members from across our now-expanded network. Members had expertise in reentry programs and higher-education-in-prison (HEP) programs, other academic programs, and nonprofit and for-profit companies. The groups consisted of a minimum of 50% (and more usually 75%) formerly incarcerated people, in our consistent effort to keep the voice of the formerly incarcerated at the forefront of the work. In that regard, we had redoubled our efforts since the founding of the Affinity Groups.

INTERNSHIP

The STEM-OPS Internship Working Group was facilitated by Princeton's Prison Teaching Initiative (PTI). **Focus:** Growing STEM research internship opportunities for currently and previously incarcerated people. **Goal:** To create pathways for system-impacted students to engage in research opportunities and pursue promising academic and professional careers in STEM. This group developed a six-part Internship toolkit designed to support higher education programs in creating summer internship programs or strengthening existing programs to increase access to STEM-based research opportunities for justice-impacted undergraduates.

MENTORING

The Mentoring Working Group was facilitated by Prison to Professionals (P2P). **Focus:** Mentors are a key aspect of any successful person's journey. For those of us with criminal convictions, who come from disadvantaged backgrounds, or who face crippling adversities, mentorship becomes a necessity for survival. Despite all our greatest efforts, without mentors and support we would not have overcome the adversities that we have. **Goal:** To create mentoring networks made up of and for currently and formerly incarcerated people and scholars to thrive in STEM and academics. This group developed a guide that highlights the need for effective mentoring that hinges on (1) tailored instruction methods, (2) a focus on education among formerly incarcerated individuals, and (3) the adoption of trauma-informed practices—all while recognizing the unique experiences of formerly incarcerated persons.

DATA AND MEASURES

The Data and Measures Working Group was facilitated by Vanderbilt University's Institute for Race Research and Justice (RRJ). **Focus:** Co-create strategies and tools to expand definitions of success in data and measures in STEM and in HEP programs. Through voice and story, we build experiential knowledge as data points, advancing what we know about STEM and HEP programing based on expansive understandings of empirical data. **Goal:** To increase access to data inside facilities to support a more culturally responsive research and evaluation infrastructure and to involve those who are being judged as central to writing the definition of success. The group developed the STEM-OPS Survey for HEP Alums, which was designed to help evaluate HEP programs and to better understand the needs of people participating in them, identifying strategies to maximize their impact.

LAB ASSISTANT PROGRAM

The Lab Assistant Program Working Group was created later than the original Working Groups and was facilitated by Operation Restoration. As part of STEM-OPS, Operation Restoration's Lab Assistant Program aims to provide incarcerated women with educational opportunities and training in science, technology, engineering, and mathematics (STEM) fields. **Goal:** To create a white paper describing how this innovative program addresses the extreme shortage of laboratory assistants in the medical field and seeks to empower women through education, foster critical-thinking skills, and create pathways for successful reintegration into society upon release. This white paper outlines the guiding practices of the program, identifies barriers to implementing STEM education in prison settings, and provides proven strategies to overcome these barriers.

SPEAKERS' BUREAU

The Speakers' Bureau Working Group was facilitated by P2P. It was created to increase awareness in the general public, higher educational institutes, and STEM employers on the importance of supporting incarcerated and formerly incarcerated people to pursue STEM education and careers.

TECHNOLOGY

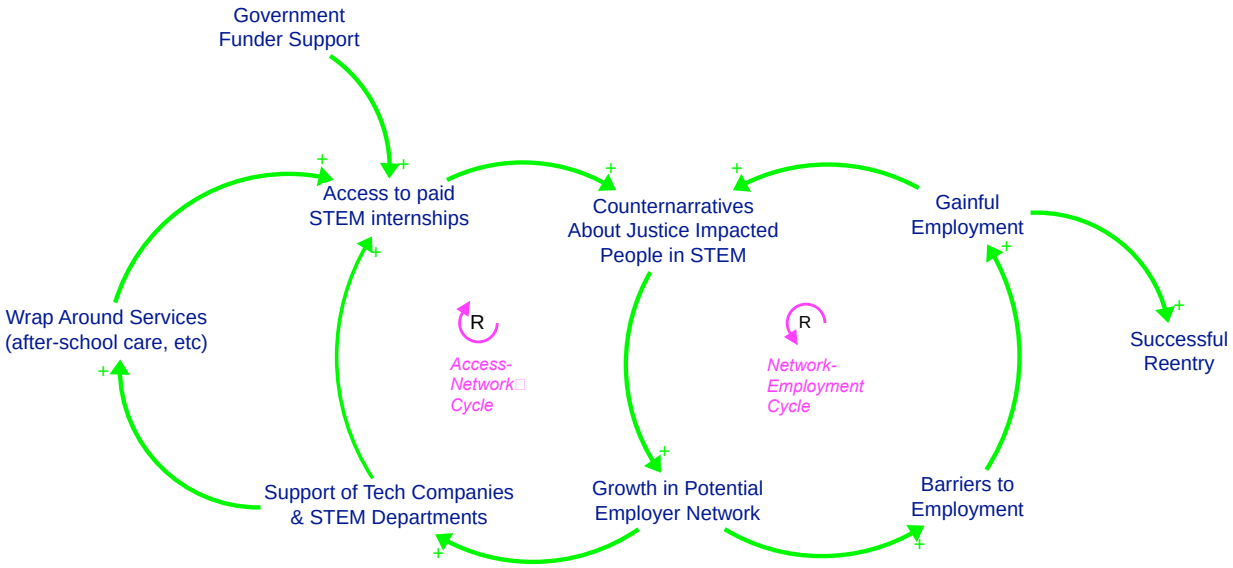
Focus: Increasing and improving access to technology for currently and previously incarcerated people. **Goal:** To ensure system-impacted people have access to communication and information technology to pursue education and careers and obtain technology skills and consistent access to current technology necessary to succeed in STEM education and careers.

The members joined with the technology Working Group of the *Smart & Connected Communities Planning Grant: Prisons Evolving as Connected Communities* (PEaCC), which grew out of earlier STEM-OPS baseline research. This Working Group envisioned a model of a prison as a connected community and created information and communication technology (ICT) principles and standards to address issues unique to prisons. The initial principles and standards are geared toward meeting all stakeholder needs while also disrupting socio-systemic factors to facilitate repositioning prisons as equitable habilitative communities supporting successful reentry.

Systems Maps and STEM-OPS Products: Solution-based Systems Maps

The EDC research group worked closely with the Working Groups and their facilitators to develop systems maps to illustrate the systems and the solutions each group was working on. The following are simplified maps illustrating each group's work and the places where they felt they could have impact.

THE INTERNSHIP WORKING GROUP SYSTEMS MAP

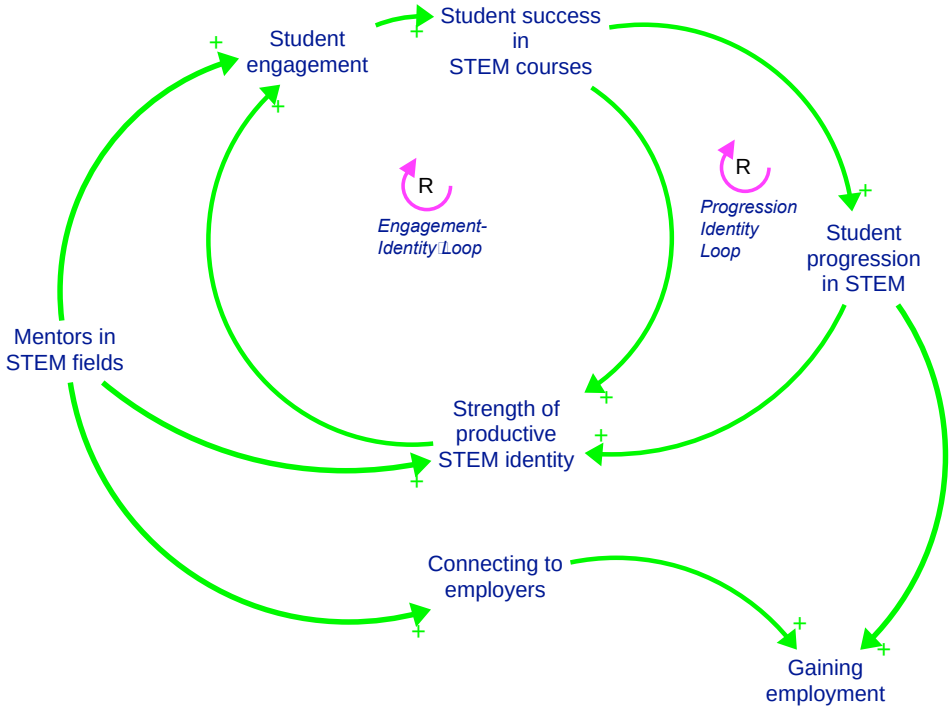


Internships feature in several of the systems maps because internships impact many variables, such as Counternarratives about Justice-Impacted People, Support of Tech Companies and STEM Departments, and, ultimately, Gainful Employment. This section of a simplified Internships Systems Map illustrates two reinforcing virtuous/vicious cycles that share some common variables. Because these two loops share variables in common, when one is working in a virtuous cycle it drives the other to do the same, or vice versa. We will describe these from the virtuous perspective.

1. The ***Access Network Loop*** should be read as follows (starting point is random):
   - An **increase** in Access to Paid STEM Internships leads to an increase in Counternarratives About Justice-Impacted People.
   - An **increase** in Counternarratives leads to **growth** in the Potential Employer Network.
   - An **increase** in the Potential Employer Network leads to an **increase** in Support of Tech Companies and STEM Departments.
   - An **increase** in Support of Tech Companies and STEM Departments leads back to a further **increase** in Access to Paid STEM Internships.
   - Backing up to the Growth in Potential Employer Network variable, the Access Network Cycle branches to the right and **leads into** the Network Employment Cycle.

2. As a virtuous cycle, the ***Network Employment Cycle*** should be read as follows:
   - An **increase** in Access to Paid STEM Internships leads to an **increase** in Counternarratives About Justice-Impacted People.
   - An **increase** in Counternarratives leads to a **growth** in the Potential Employer Network.
   - An **increase** in the Potential Employer Network leads to **reducing** Barriers to Employment.
   - As Barriers to Employment are **reduced,** there is an **increase** in Gainful Employment and Successful Reentry.

THE MENTORING WORKING GROUP SYSTEMS MAP



Mentorship is found on several systems maps, as an increase in access to quality mentors leads to many successful outcomes, such as more engagement, more success, more productive identity, and, ultimately, more employment in STEM.

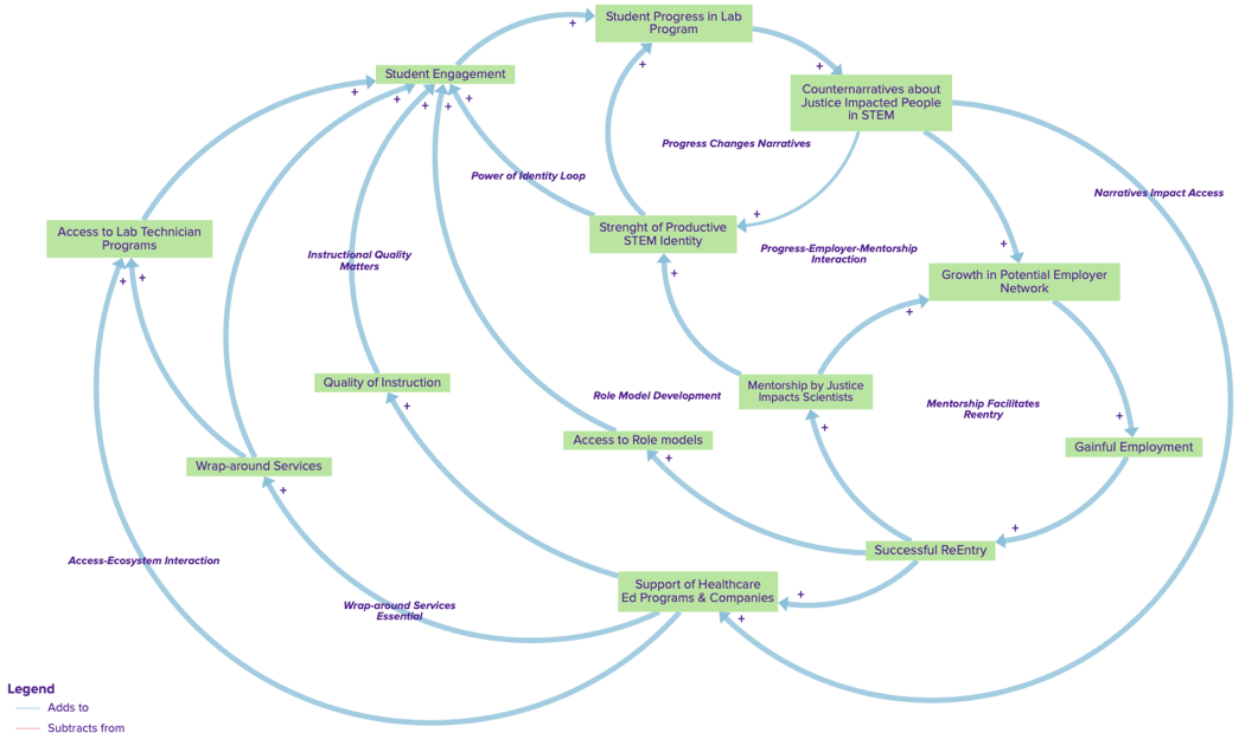
1. The ***Engagement-Identity Loop*** is a virtuous Reinforcing Loop that should be read as follows:
   - As access to Mentors in STEM Fields **increases, BOTH** Student Engagement **AND** Strength of Productive STEM Identify also **increase.** (This is interesting, as Mentors impact this loop in two places; this also occurs in multiple other places in this loop, suggesting this can quickly accelerate.)
   - First, going upwards from Mentors in STEM fields, as Student Engagement **increases,** Student Success in STEM Courses also **increases**.
   - As Student Success in STEM Courses **increases**, **BOTH** Student Progression in STEM **AND** Strength of Productive STEM Identity **increase**.
   - As Student Progression in STEM **increases, BOTH** Strength of Productive Student Identity **AND** Gaining Employment **increase**.
   - Second, going out to the right from Mentors in STEM Fields, Strength of Productive STEM Identity increases, which also supports an **increase** in Student Engagement.

2. The ***Progression-Identity Loop*** should be read as follows:
   - As access to Mentors in STEM Fields **increases,** Student Engagement **increases** (as before).
   - As Student Engagement **increases,** Student Success in STEM **increases**.
   - As Student Success in STEM **increases,** Student Progression in STEM **increases**.
   - As Student Progression in STEM **increases**, **BOTH** Strength of Productive Student Identity **AND** Gaining Employment **increase**.

- The **increase** in Strength of Productive Student Identity leads back to an **increase** in Student Engagement, and the cycle continues.

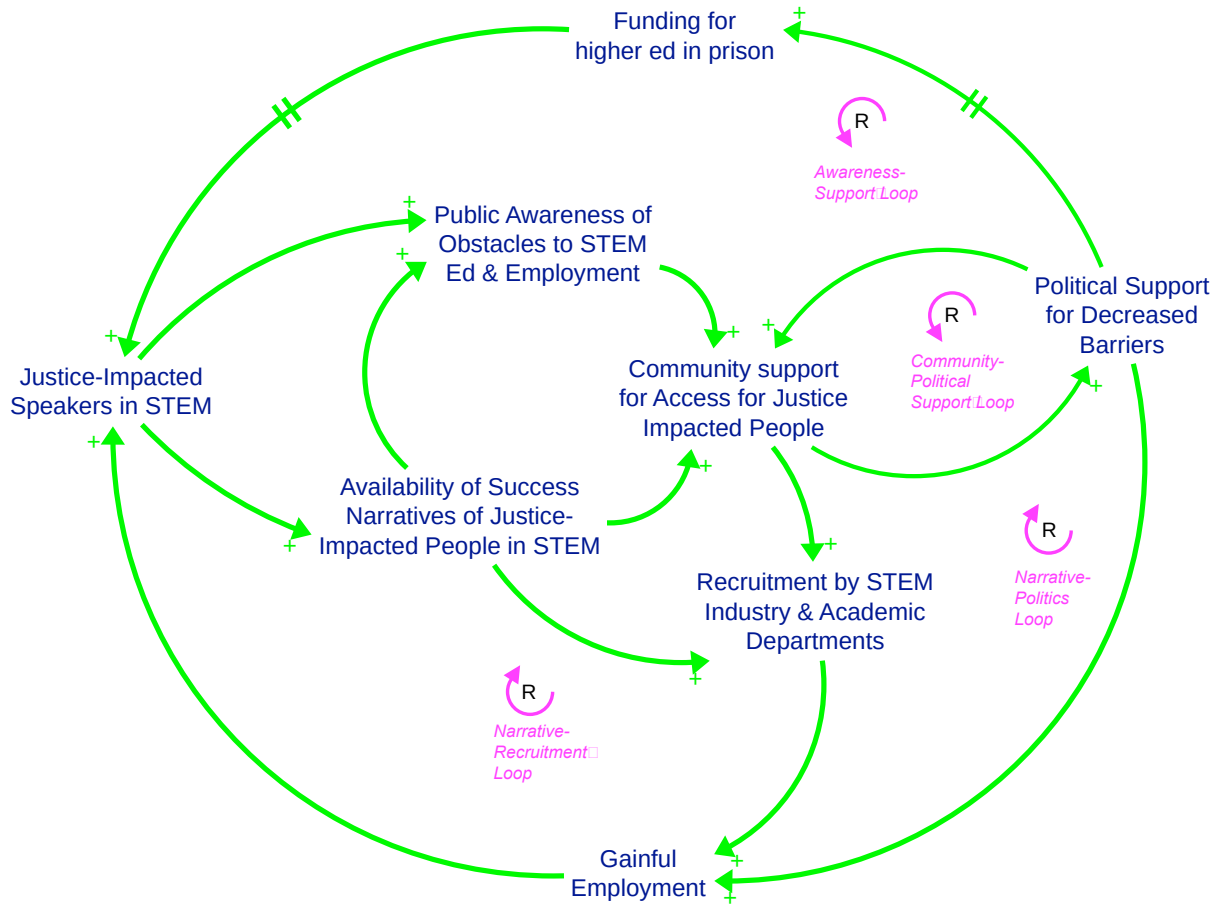
THE LAB ASSISTANT PROGRAM SYSTEMS MAP

The Lab Assistant Program map has many of the variables that are seen in the Internship and Mentoring maps. This is not surprising, as both are crucial elements of a high-quality program. The Lab Assistant Program Systems Map illustrates how a high-quality lab assistant program leads to greater student engagement, success in education, jobs, and successful reentry. Reading the map, you can see how student success in lab assistant programs leads to counternarratives about justice-impacted people. This helps grow greater support for such programs and provides the funding to increase both wraparound services and the quality of instruction. Within the larger loop, you also can see how access to role models and mentorship support both student engagement and growth of strong STEM identities, leading to progress and success.



1. With the starting point ***Access to Lab Technician Programs*** at left, the map should be read as follows:
   - As Access to Lab Technician Programs **increases,** Student Engagement increases.
   - As Student Engagement **increases,** Student Progress in the Program **increases**.
   - As Student Progress **increases,** Counternarratives about Justice-Impacted People **increase**.
   - As Counternarratives about Justice-Impacted People **increase,** Support of Healthcare Education Programs and Companies **increases**.
   - As Support of Healthcare Education Programs and Companies **increases,** greater access to high-quality Support of Healthcare Education Programs and Companies **increases**, and Wraparound Services crucial for program success **increase**.

THE SPEAKERS' BUREAU SYSTEMS MAP



The Speakers' Bureau is found in several systems maps because it has wide ranging impact on community awareness, community support, political support, greater funding, and employment in STEM. This section of the Speakers' Bureau Systems Map shows four reinforcing virtuous cycles.

1. The ***Community–Political Support Loop*** on the top right-hand side should be read as follows:
   - An **increase** in Justice-Impacted Speakers in STEM (on the left) leads to an **increase** in Public Awareness of Obstacles to STEM Ed & Employment.
   - An **increase** in Public Awareness of Obstacles to STEM Ed & Employment leads to an **increase** in Community Support for Access for Justice-Impacted People.
   - An **increase** in Community Support for Access for Justice-Impacted People leads to an **increase** in Political Support for Decreased Barriers.
   - This **increase** in Political Support for Decreased Barriers leads to advocacy and platforms that can further **increase** Community Support for Justice-Impacted People (and two other variables discussed in other loops).

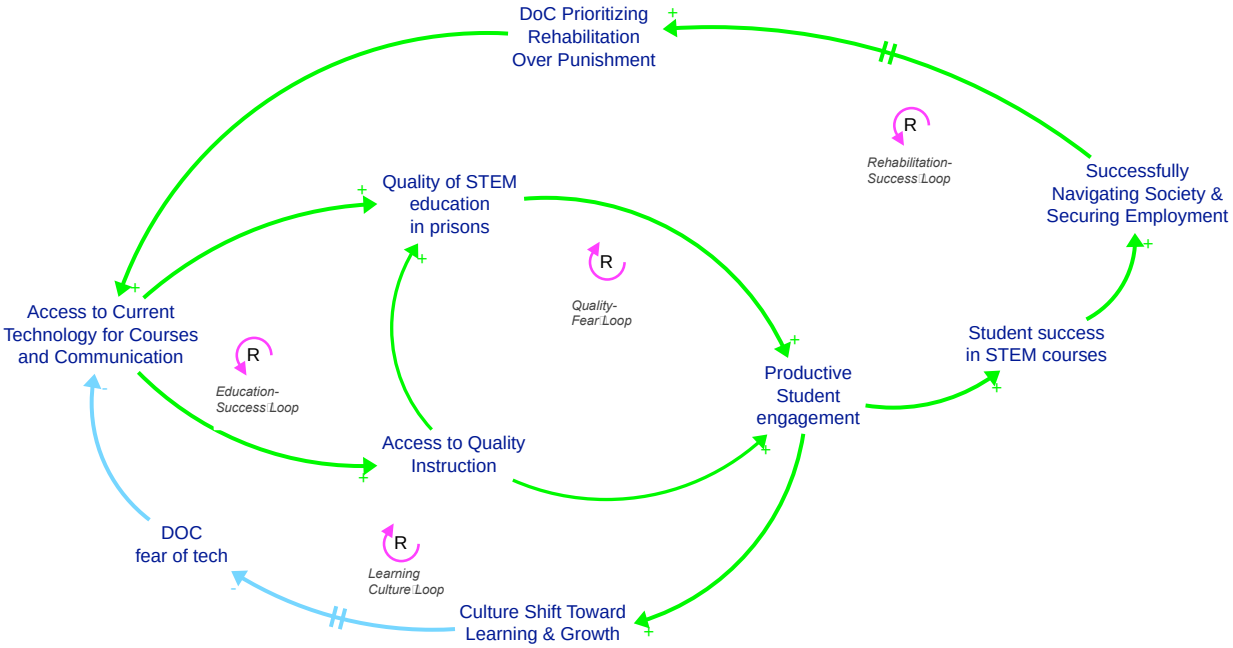
2. The ***Narrative–Politics Loop*** should be read as follows:
    - An **increase** in Justice-Impacted Speakers in STEM leads to an **increase** in Availability of Success Narratives of Justice-Impacted People.
    - This **increase** in availability promotes an **increase** in Community Support for Access for Justice-Impacted People.
    - An **increase** in Community Support leads to an **increase** in Political Support for Decreased Barriers.
    - An **increase** in Political Support for Decreased Barriers lead to an **increase** in Gainful Employment, which in turn means there can be **more** Justice-Impacted Speakers in STEM.

3. The ***Awareness Support Loop*** should be read as follows:
    - An **increase** in Justice-Impacted Speakers in STEM leads to an **increase** in Public Awareness of Obstacles to STEM Ed & Employment.
    - An **increase** in Public Awareness of Obstacles to STEM Ed & Employment leads to an **increase** in Community Support for Access for Justice-Impacted People.
    - An **increase** in Community Support for Access for Justice-Impacted People leads to an **increase** in Political Support for Decreased Barriers.
    - An **increase** in Political Support for Decreased Barriers leads, over time, to an **increase** in Funding for Higher Ed in Prison.
    - An **increase** in Funding for Higher Ed in Prison leads, over time, to an **increase** in Justice-Impacted Speakers in STEM.

4. The ***Narrative Recruitment Loop*** should be read as follows:
    - An **increase** in Justice-Impacted Speakers in STEM leads to an **increase** in the Availability of Success Narratives of Justice-Impacted People in STEM.
    - An **increase** in the Availability of Success Narratives of Justice-Impacted People in STEM leads to an **increase** in Recruitment by the STEM Industry and Academic Departments.
    - An increase in Recruitment by the STEM Industry and Academic Departments leads to an **increase** in Gainful Employment, which leads back to an **increase** in Justice-Impacted Speakers in STEM.

THE TECHNOLOGY WORKING GROUP SYSTEMS MAP

Technology is present in many aspects of the systems map and is implicated in at least 14 different high-level variables. In this section of the Technology Systems Map, we highlight four of the reinforcing cycles. Again, we describe these as virtuous cycles, but they can be either virtuous or vicious.



1. The ***Quality–Fear Loop*** should be read as follows (starting point can be randomly chosen):
   - As Access to Current Technology **increases**, the Quality of STEM Education in Prisons **goes up**.
   - As the Quality of STEM Education in Prisons **goes up**, the Productive Student Engagement **goes up**.
   - As Productive Student Engagement **goes up,** there is a Culture Shift Toward Learning and Growth.
   - As the Culture Shift Toward Learning and Growth **increases,** there is, over time (symbolized by two short lines on the arrow), a **decrease** in the Department of Corrections' Fear of Technology.
   - As the Fear of Technology **decreases,** the access to Current Technology for Courses and Communication **increases**.
   - As access to Current Technology **increases,** access to Quality of STEM Education **increases**.

2. The ***Rehabilitation-Success Loop*** should be read as follows:
   - As the Department of Corrections Prioritizing Rehabilitation over Punishment **increases**, access to Current Technology for Courses and Communication **increases**.
   - As Access to Current Technology **increases,** Access to Quality Education **increases**.
   - As access to Quality Education **increases,** Productive Student Engagement **increases**.
   - As Productive Student Engagement **increases,** Student Success in STEM Courses **increases**.
   - As Student Success **increases,** there is an **increase** in formerly incarcerated students Successfully Navigating Society and Securing Employment.

- As there is an **increase** in formerly incarcerated students Successfully Navigating Society and Securing Employment, there is an **increase** in the Department of Corrections Prioritizing Rehabilitation.

3. The ***Learning Culture Loop*****,** as a virtuous Reinforcing Loop, should be read as follows:
   - As there is a Culture Shift Toward Learning & Growth over time (the double slash on this relationship line indicates significant time passes for this to happen), there is a **decrease** in the Department of Corrections Fear of Technology.
   - As the DOC Fear of Technology **decreases**, there is an **increase** in Access to Current Technology for Courses and Communication.
   - As Access to Technology **increases**, there is an **increase** in Access to Quality Instruction.
   - With **increased** Access to Quality Instruction, there is an **increase** in Productive Student Engagement.
   - As Productive Student Engagement **increases,** this **reinforces** the Culture Shift Toward Learning & Growth.

4. The ***Education Success Loop*** should be read as follows:
   - As Access to Quality Instruction **increases,** Productive Student Engagement **increases.**
   - As Productive Student Engagement **increases,** Student Success in STEM Courses **increases.**
   - As Student Success in STEM Courses **increases,** there is an **increase** in the numbers of formerly incarcerated students Successfully Navigating Society & Securing Employment.
   - As the numbers of students Successfully Navigating Society & Securing Employment **increase,** there is an **increase** in the Department of Corrections Prioritizing Rehabilitation over Punishment.
   - As there is an **increase** in the Department of Corrections Prioritizing Rehabilitation over Punishment, there is an **increase** in Access to Technology for Courses and Communication.
   - As Access to Technology for Courses and Communication **increases,** there is an **increase** in Access to Quality Instruction.

HOW WE GET TO SOLUTIONS

We can use the systems maps to illustrate the ways that the tools STEM-OPS has created to intervene in the system that can lead to successful reentry. There are five specific ways to intervene in a system:

1. **Variables: Can you change a variable in the system?**
2. **Feedback Loops: Is there a feedback loop you can speed up, slow down, or break?**
3. **Rules That Govern the System: Can you change or create a new rule to govern the system differently?**
4. **Goals of the System: Can you change or create a new goal for the system?**
5. **Mental Models: Can you change or create a new mental model?**

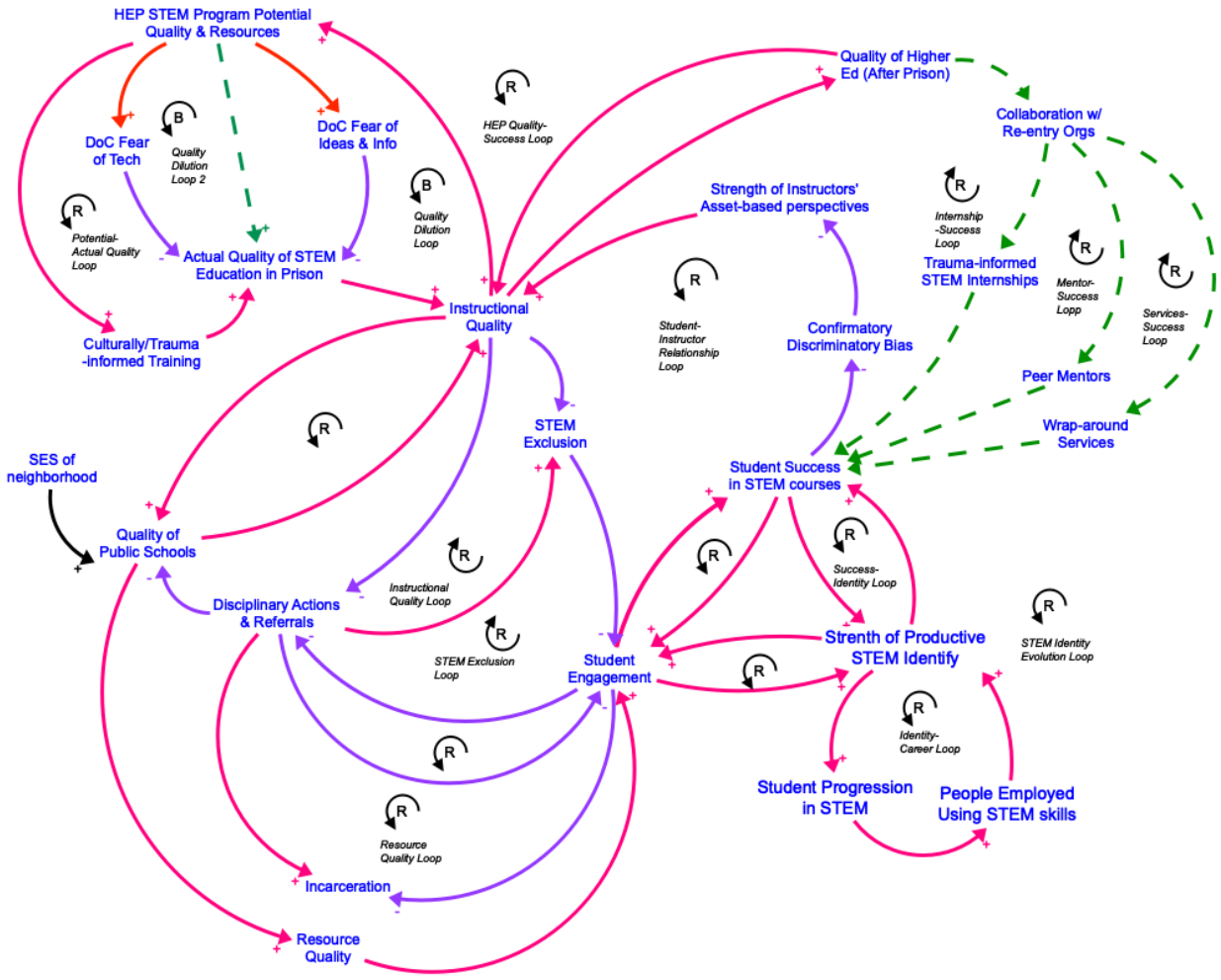


Figure 5. Map Illustrating Ways to Intervene in the Carceral System (Dotted Green Lines)

The map shown in Figure 5 illustrates, with the addition of the green dotted lines, ways to intervene in the carceral system that can lead to greater success in reentry for incarcerated individuals. By using the findings and the toolkits developed by the STEM-OPS working groups, we can build new goals and rules for the system, adding new variables and feedback loops to our maps to build a new mental model of what successful reentry can look like. Specifically, in the map above we have envisioned new rules and goals for what reentry should look like—adding STEM-OPS tools such as peer mentoring, trauma-informed STEM internships, and wraparound supports to create pathways to successful reentry.

CONCLUSION

Our community-based research allowed us to create visual representations of the complexity of the carceral system. We looked closely at different areas and variables of the carceral system where our survey and Affinity Group discussions saw obstacles to STEM education and careers for formerly incarnated people. This enabled us to think strategically about ways to impact the system in those areas in ways that would support our goals with continued improvement via virtuous cycles, rather than inadvertently continuing harm in a well-meaning, but vicious, cycle.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