

Root cause analysis as a tool for forging shared vision and partnership: Lessons for strengthening the process

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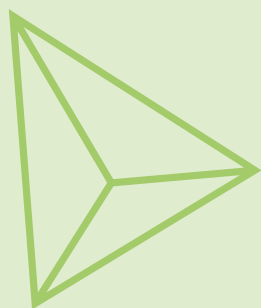
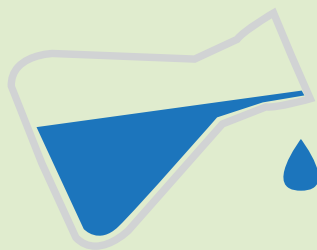
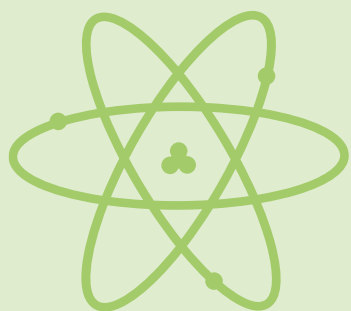


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Abstract

In this Rapid Community Report - Process Reflection, the STEM PUSH Network (Pathways for Underrepresented Students to HigherEd), an NSF INCLUDES Alliance, describes a root cause analysis process used to build the conceptual foundation of the improvement network and establish a shared vision and clear roles for the partnership. Four layers of reflection, including internal evaluation, external evaluation, advisory council review, and an NSF reverse site visit, surfaced the need for and strategies to strengthen equity and youth agency in the root cause analysis process.

Keywords:

Root cause analysis, youth agency, shared vision, partnership

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Overview

Building shared vision and partnership to improve and sustain a network requires a common understanding of the problems the network aims to address, as well as an examination of the systems creating those problems. This is crucial for any collective impact work, and especially in work seeking to address complex and stubborn social problems (Bryk et al., 2015; Russell et al., 2017).

This process reflection describes the [STEM PUSH Network](#)'s (Pathways for Underrepresented Students to HigherEd) engagement in designing, implementing, evaluating, and documenting a root cause analysis to help network partners build a shared understanding of the problem the Network seeks to address, the system that supports the problem, and the levers for systemic change during the Network's first year. **The root cause analysis was framed by the problem: Pre-college STEM programs (PCSPs) are not yet systematically reducing disparities and cultivating equity in STEM college-going and persistence among racially and ethnically minoritized students.**

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The understanding of the root causes of the problem was visualized using a tool called a *fishbone diagram*. The diagram was subsequently used to co-construct a network-wide theory of improvement, helping organize the efforts of a diverse group of network partners while keeping the collective aim at the forefront. The STEM PUSH Network's aim is to increase the number of racially/ethnically minoritized PCSPs who are admitted to and persist in STEM undergraduate study.

The root cause analysis process enabled the network to come together in pursuit of the shared aim and built buy-in to the work. Internal and external evaluation efforts, including feedback from

the NSF reverse site visit, supported team reflection on the process. The reflections led to actions to better center and represent systemic racism in the root cause analysis and to consider ways to activate the voices of those the work is intended to benefit in the design and implementation of the network. Lessons from this effort are applicable to others embarking on collective impact efforts including but not limited to the establishment of a Networked Improvement Community (NIC).

Project Challenge and Context

The seeds of the STEM PUSH Network were planted in 2013, when the leaders of Gene Team — a pre-college STEM program (PCSP) at the University of Pittsburgh — noticed a disturbing trend. The high school students with whom they had been working were talented critical thinkers who demonstrated a real love of, aptitude for, and mastery of STEM skills. The students, who were mostly racially/ethnically minoritized, were energized about STEM, but they were not being accepted into STEM undergraduate programs at the main campus of their regional university system. Upon further investigation, Gene Team leaders found their students' applications were not viewed favorably in comparison to applicants with higher standardized test

scores and other attributes such as robust portfolios of Advanced Placement courses — two metrics known to exhibit racially biased patterns of outcomes and access (Chatterji, et al. 2021; Geiser, 2015).

The inequitable admissions outcomes had implications not only for the individual students but for STEM fields at large. Diverse representation in STEM is critical for bringing rich ideas and innovation to our world, and for addressing some of society's most pressing problems — especially those disproportionately affecting racially/ethnically minoritized communities.

Gene Team staff believed their students would perform well at their university because they had witnessed their passion and ability and were frustrated by the apparent lack of influence their students' success in the Gene Team program had in the admissions process. They reached out to operators of other pre-college STEM programs at the university including INVESTING NOW, the Hillman Academy, and the Technology Leadership Initiative and discovered that their frustrations were shared broadly across these programs.

The PCSPs had been operating in silos with no history of collaboration, but they decided that this challenge was one that they must tackle together. With funding from [NSF INCLUDES](#) through a Design and Development Launch Pilot (DDL P #1744446) and in partnership with admissions representatives from the University of Pittsburgh, they launched the initial phase of work that has evolved into a multi-year initiative.

At the conclusion of the DDL P initiative, the team's findings validated the theory that students' successful participation in PCSPs could be valued currency in the STEM college admissions process, particularly as a means of achieving more equitable admissions outcomes. At the implementation level, the DDL P resulted in a new pathway for consideration of students' PCSP experiences in STEM undergraduate admissions at the University of Pittsburgh.

In 2019, the University of Pittsburgh team formed the Broadening Equity in STEM (BE STEM) Center to advance this work. Building on lessons learned from the DDL P, the

team adopted the **goal of improving racial equity in the undergraduate college STEM admissions process** by leveraging the robust set of urban PCSPs that already work with racially/ethnically minoritized students. Members of the DDL P team, anchored by faculty from the University of Pittsburgh and the STEM Learning Ecosystems Community of Practice (SLECoP) subsequently applied for and received an NSF INCLUDES Alliance award to reinvent the relationship between PCSPs and higher education admissions offices.

The STEM PUSH Network brings PCSPs together as a collective body, distinct from Out-of-School Time (OST) and STEM education networks. Additional organizations and individuals have been mobilized as network partners to forge a meaningful role for PCSPs in creating more equitable pathways to STEM higher education, reimagining an admissions process in which racially/ethnically minoritized students' accomplishments and talents in STEM are more valued and visible.

While college admissions offices are a focal point for creating change, consideration of STEM pathways as a system also means attending to ways in which PCSPs can strengthen their capacity to serve racially/ethnically minoritized students well, in equitable and culturally sustaining ways. By focusing the root cause analysis on the problem of PCSPs not yet systematically reducing disparities, it compelled network partners to attend to this need and consider how different partners may be activated strategically in service of a shared vision that takes multiple facets of the STEM pathway into account.

Building Collaborative Infrastructure for Change

The diverse stakeholders at the nexus of pre-college STEM programs for racially/ethnically minoritized students and undergraduate admissions have traditionally lacked dedicated spaces to discuss the intersections of their work or to come together collaboratively in pursuit of a common goal. The STEM PUSH Network is using a Networked Improvement Community (NIC) change model to bring together leaders of PCSPs, STEM Learning Ecosystem Community of Practice (SLECoP), regional urban ecosystem leaders, undergraduate admissions professionals, STEM

professionals, experts in culturally sustaining practices, and improvement scientists.

In addition to these many stakeholders, the STEM PUSH Network is organized and guided by an internal STEM PUSH Hub team, the backbone organization Teaching Institute for Excellence in STEM (TIES), an advisory council of experts and leaders in relevant fields, and the Alliance's National Science Foundation program officer and experts engaged through the NSF reverse site visit process.

The STEM PUSH Network adopted the NIC model to organize collective impact across these diverse partners because it offers a disciplined and evidence-based approach to solving complex problems. [LeMahieu \(2015\)](#) identifies four defining features of NICs:

- Focused on a well-specified aim
- Guided by a deep understanding of the problem, the system that is producing it, and a theory of improvement relevant to it
- Disciplined by the rigor of improvement science
- Coordinated to accelerate the development, testing, and refinement of interventions and their effective integration into practice.

In the early stages of the development of a NIC, members engage in careful inquiry to understand the system that produces and sustains the problem they are trying to solve. They then develop a shared aim and build their theory of improvement so all members understand the path they

are on to reach their aim. These early NIC development approaches are techniques for building elements of collaborative infrastructure including shared vision and partnerships.

Improvement science offers a range of techniques and tools to understand the problem and the system that produces it, one of which is root cause analysis (WeTeachNYC, n.d.). In STEM PUSH, the Hub team convened a subset of network partners who had not previously worked together to engage in a collaborative root cause analysis process.

The root cause analysis process was conducted through eight virtual work group sessions over the course of 12 weeks and engaged 15 partners from multiple sectors and roles: four PCSPs, four representatives from urban ecosystems, three representatives from the national STEM ecosystems, and three college admissions professionals. The STEM PUSH Hub also participated which included university STEM faculty, PCSP leaders, improvement science and learning science experts, and an equity, inclusion, and justice scholar.

Reflection Questions and Process

The root cause analysis was designed to help partners collectively develop a systemic understanding of the following problem: **PCSPs are not yet systematically reducing disparities and cultivating equity in STEM college-going and persistence among racially and ethnically minoritized students.** The problem statement was selected by the STEM PUSH Network Hub to incorporate the broad range of partner perspectives and help focus partner contributions toward the larger Alliance goals and objectives while leaving space to build partner buy-in.

Root Cause Analysis Process and Products

Collaborative tasks conducted by the partners included reviewing research on disparities in STEM undergraduate enrollment, persistence, and attainment; reviewing research on racial bias in STEM K-12, admissions, and undergraduate STEM departments; sharing relevant data from participants' own organizations; and primary data collection via empathy interviews with PCSP students and alumni, K-12 school-based staff and admissions officers (Biag et al., 2018; The Learning Accelerator, n.d.). Participants reviewed these inputs in scaffolded reflective tasks and Hub-facilitated approaches such as a [“5 Whys” protocol](#) in order to drill down to root rather than surface causes.

The result of these activities was a fishbone diagram in which the root causes of the problem (**PCSPs are not yet systematically reducing disparities and cultivating equity in STEM college-going and persistence among racially and ethnically minoritized students**) were specified. The function of a fishbone diagram is to visualize and cluster root causes according to thematic categories within a system, such as “measures,” “infrastructure,” “people,” etc.

The root causes related to the problem included conditions related to PCSP structures, staffing, and funding that limit their capacity to effectively serve racially and ethnically minoritized students. Other root causes had to do with drivers of college admissions such as institutional financial

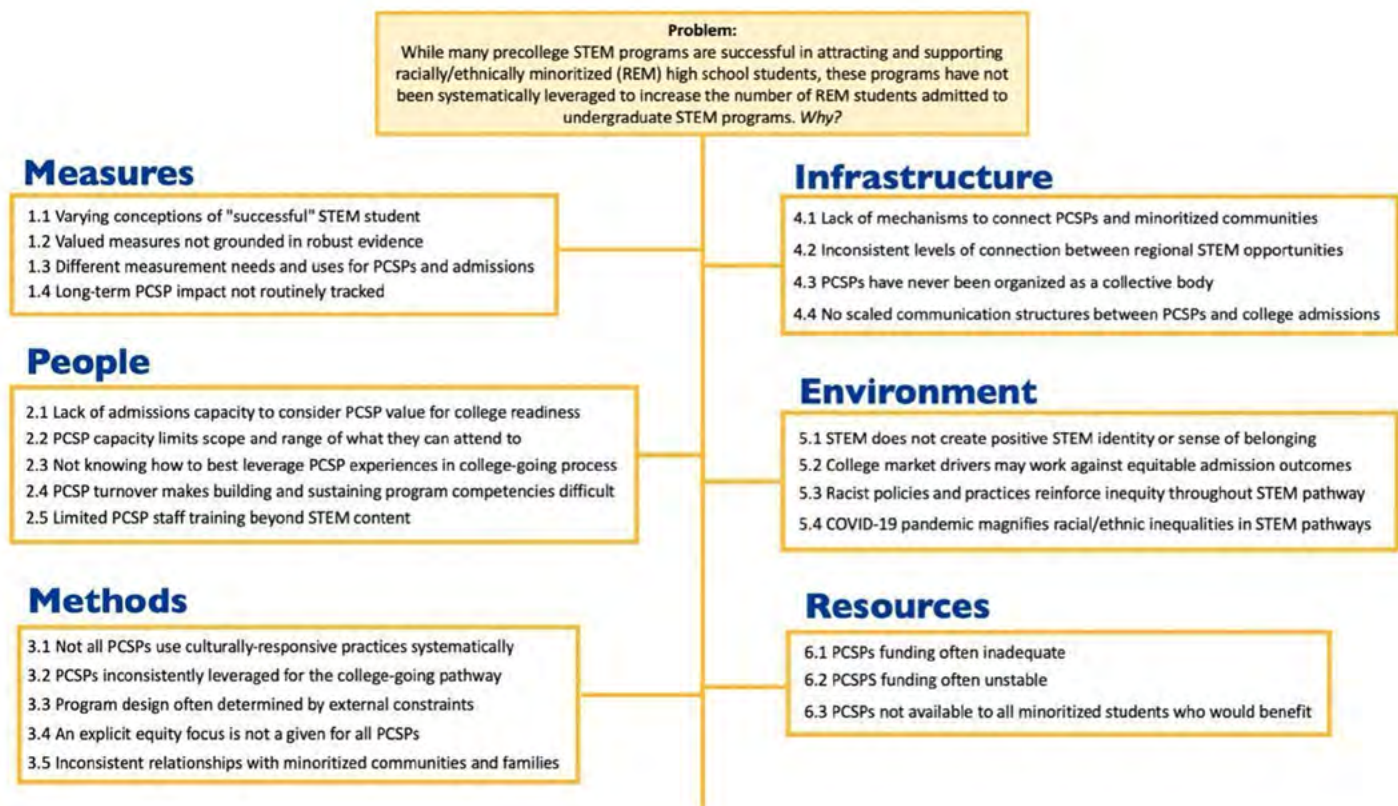


Figure 1. A fishbone diagram was used to visualize and cluster root causes according to thematic categories, including conditions related to structures, staffing, and funding that limit capacity to effectively serve racially/ethnically minoritized students.

goals and racist assumptions and practices embedded within STEM fields which are reified in undergraduate STEM departments. Still other root causes had to do with the chasm that exists between the PCSP and higher education admissions offices due to lack of shared language, goals, or mechanisms for communicating about students.

The first cohort of STEM PUSH PCSPs engaged with the draft fishbone diagram through facilitated activities that elicited their thinking about causes of the problem and critique of the existing draft. The Hub team iterated on the feedback from PCSPs to produce a revised diagram. Finally, we asked each partner to identify which root causes they felt agency to address.

The exercise identified areas where partnership would be necessary across sectors, organizations, and programs. For

example, “lack of ways to connect PCSPs and minoritized communities” was identified as a root cause. PCSPs individually are unlikely to be able to address this challenge alone, but partnerships with STEM ecosystems and other community intermediary organizations could create effective infrastructure for sustained connections.

The fishbone diagram, in combination with the results of the research review, data collection, and student interviews, seeded the development of a shared network aim and theory of improvement, which identifies

the levers the STEM PUSH Network can target to address the root causes identified through the analysis. Since a range of partners were engaged in developing the shared understanding of the system producing our problem – the intention of our collective approach to work on the problem – partners felt more ownership and were more able to communicate the purpose and strategy of the Network to their respective stakeholders.

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Gathering Feedback on the Root Cause Analysis Process

The STEM PUSH Network seeks to keep the voices and perspectives of students from groups who are racially and ethnically minoritized in STEM at the center of our work, and a core tenet of the NIC model is to remain “user-centered and problem focused.” We know that as we build shared vision and partnership for collective impact, centering equity is crucial for the ultimate success of the work. Thus, throughout our root cause analysis work, we layered in evaluation, data collection, and critical friend feedback to help us reflect on the following question: **How did we include and elevate diverse voices and perspectives to understand the system producing our problem?**

To support the STEM PUSH Hub’s continuous improvement, the root cause analysis process was studied using both an internal evaluation conducted by the Hub and an external evaluation led by Dr. Ayesha Boyce and her team at the University of North Carolina-Greensboro. Dr. Boyce utilizes a “Values-Engaged Educative Evaluation” model which intentionally supports explicit attention to issues of diversity, equity, and responsiveness to the culture and context of the program under study.

Internal Evaluation

The internal evaluation was organized to provide the Hub team with feedback about how well the root cause analysis content and process design was supporting the intended engagement, insight, and learning. Internal evaluation data were available during the implementation of the 12-week process, and the STEM PUSH Hub team reflected on these data during weekly design and development meetings, using the insights to make real-time adjustments to the overall design of the process as well as specific adjustments to the format of the work and the conduct of the sessions. The data included, for example, periodic participant surveys about

External Evaluation

The external evaluation was conducted a few months after the completion of the root cause analysis using a Values-Engaged Evaluation framework. The evaluation team conducted eight 25–50-minute interviews with a representative sample of the participants to understand

The internal evaluation included review of partner tasks in the root cause analysis process, notes from work sessions, and surveys of participants in the root cause analysis at three different points in time that asked about their understanding of the problem, the session design and implementation, and the value of the work. The external evaluation included observation of root cause analysis sessions and interviews with eight of the participants from each of the three role groups (PCSPs, ecosystems, admissions) represented.

In addition to the internal and external evaluations, external feedback and thought partnership were provided by the STEM PUSH advisory council and the NSF reverse site visit team. The STEM PUSH Network advisory council reviewed and provided feedback on the draft fishbone diagram. Finally, during our March 2021 NSF reverse site visit, the review panel, which included experts in justice-oriented STEM teaching and learning, provided feedback on the root cause analysis process. Each of these evaluations and reviews resulted in written reports or products that the STEM PUSH Hub team reflected upon during routine bi-weekly meetings as the artifacts became available.

the format, structure, facilitation, and content of the root cause analysis meetings and tasks.

At the conclusion of the root cause analysis, a comprehensive internal evaluation report was produced and the STEM PUSH Hub team held a debrief session to codify the lessons learned. The lessons included insights such as the importance of relationship-building work with the participants, the challenge of doing so in fully virtual formats, identifying the groupings that most supported expansive thinking about root causes and improving productivity by limiting session length to no more than an hour, among many others.

their experiences and perspectives of the process. The report from the evaluation team that analyzed these interviews helped the STEM PUSH Hub team recognize that additional perspectives were essential to ensuring the identified root

causes would reflect the breadth of the overall system in which the problem exists.

To engage these additional perspectives, the fishbone diagram was shared with all ecosystem leaders and PCSP leaders in the network as well as with the STEM PUSH advisory council. Feedback from these partners prompted the Hub to include racism as a primary root cause (“Racist policies and practices that reinforce inequity throughout STEM pathway”), with attendant secondary causes of

disparities in PK-12 public education STEM (quality of instruction, college counseling, support for college-going requirements); bias in college admission exams, processes, and financing; and cultural bias across STEM disciplines and K-20/workforce. Including this in the diagram ensured the Network would foreground a racial equity lens on the work and avoid perpetuating deficit orientations towards students and communities.

Reverse Site Visit Feedback

Finally, the review at the NSF reverse site visit offered critical feedback to strengthen the work of the STEM PUSH Network. The feedback pressed the STEM PUSH Hub to advance from inclusion of youth voice through empathy interviews and research on barriers for racially/ethnically minoritized students in STEM to creating structures for meaningful student agency and partnership within the Network. These insights were discussed and an action plan drafted during a STEM PUSH Hub debrief of the reverse site visit.

Constructive Criticism

Positive aspects of the root cause analysis process

Overall, the root cause analysis process STEM PUSH implemented was effective in building shared understanding of the problem and seeding new, cross-organizational relationships among STEM ecosystems, admissions, and PCSPs. The internal and external evaluations consistently found the process was structured and implemented in ways that exposed participants to new or different parts of the system that are producing the problem, established safe and productive collaborative norms, and built new relationships among participants.

The evaluations also noted that the process included approaches that helped bridge the challenge of doing such work virtually rather than in person. The approaches included the use of the Mural collaborative whiteboard platform before the COVID-19 pandemic made these tools commonplace. The process prioritized relationship building with icebreaker activities and intentional groupings to strategically connect participants (for example, ensuring each breakout group for a task had an admissions professional, a PCSP leader, and a STEM ecosystem leader).

The most important positive finding was that participants reported that the process changed their understanding of the system that is creating and sustaining the problem. For example, four partners responded to an open-ended question on one of the internal evaluation surveys:

The root cause analysis process STEM PUSH implemented was effective in building shared understanding of the problem and seeding new, cross-organizational relationships.

“It [the root cause analysis] highlighted where my program and institution has agency to make change vs where myself, as a leader and community member need to promote and support change.”

“I learned more about the areas outside of my own concern [and] the roles they play in trying to understand and address their elements of the problem.”

“Participation highlighted the rift in communication and shared understanding between the OST [out-of-school-time] space and higher ed.”

“I underestimated the amount of fragmentation in the system and how siloed PCSPs are from the rest of the university enterprise.”

What could be improved about the root cause analysis process?

The Hub team also gained insight into strengthening the process to better position the Network to achieve its aim. Two specific process improvements were identified: injection of external review at earlier stages of the work and inclusion of those intended to benefit from the work as co-designers in the work.

- **The critical friend feedback that was most central to keeping equity at the center came from individuals who are more distant from the day-to-day work but who are knowledgeable about the focus and intent of the network and this feedback came well after the conclusion of the process.**

Specifically, the STEM PUSH advisory council and the NSF reverse site visit panel brought perspectives not influenced by the conceptual conversations from prior meetings. Their feedback was more reliant on the messages communicated exclusively through the fishbone artifact and would have been beneficial to have obtained at earlier stages of the development.

As implemented, the advisory council was engaged several months after the analysis was complete and the reverse site visit was nearly 10 months later. **In retrospect we would have identified two key review moments; one as the process was being designed but not yet implemented, and another at the conclusion of the process for immediate reaction and feedback.** The power of these knowledgeable but less-involved thought partners during earlier stages could have identified areas for improvement and accelerated the work.

- **The reverse site visit panel pressed the STEM PUSH hub team to consider more powerful and equitable ways to engage those the network intends to benefit, namely, racially/ethnically minoritized high school and undergraduate students.** Although the root cause analysis process intentionally sought student voice and experience through empathy interviewing, students did not participate directly in the analysis or in the subsequent development of the theory of improvement. The Hub team and advisory groups include individuals of varied racial and ethnic backgrounds, but not PCSP students and only one PCSP alumni.

Challenges to meaningfully incorporating youth into the project include creating equitable engagement practices and compensation, establishing appropriate IRB protocols for working with youth, navigating alignment issues between Hub team work days and student availability, and ensuring that student contributions are not tokenized. As a result of the feedback and reflection, the STEM PUSH Network is working with PCSP partners to build approaches to center student voice and agency. Approaches under consideration include:

- **A PCSP alumni co-design team** that will organize a diverse set of racially/ethnically minoritized undergraduate students who have participated in PCSPs to act as thought partners within the Network. It is anticipated that the PCSP alumni will opt into various strands of STEM PUSH work and collaborate with Hub members in designing, reflecting, deciding, adapting, and revising strategic plans, programming, and processes. The individuals would serve specified terms of service and be compensated for their time.
- **A year-long paid fellowship** could provide mutually beneficial experiences for several undergraduate students who are PCSP alumni and for the STEM PUSH Network. With additional funding, fellowships would be constructed to align with specific strands of work within the Network and occur in the summer and other times when students would be available for intensive work. Students would have the opportunity to meaningfully contribute to network design, implementation, and/or reflection sessions and have co-authorship of resulting products.
- **A PCSP high school student advisory council** organized and implemented across all the participating STEM ecosystems. Each ecosystem would be allotted several “student seats” on the STEM PUSH Network student advisory council and the ecosystems would convene these students on a regular basis to weigh in on STEM PUSH topics. Participants would be compensated for their contribution monetarily or with other valued resources.

Had the team adopted these approaches during the design phase of the root cause analysis process, we could have had student perspectives built into the entire process and their voices would have significantly contributed to our

descriptions of what matters in the system causing our problem and to identifying high leverage drivers on which to focus our joint work.

Implications and Insights: Next Steps

Although root cause analysis and the subsequent theory of improvement are explicit parts of NIC development, they are not exclusive to the NIC collective impact approach. These processes are powerful mechanisms for building shared vision and partnership across diverse stakeholders who typically do not work collaboratively and can be beneficial within other collective impact approaches.

We learned, however, that these processes can be made more effective and equitable by having knowledgeable external critical friends review the planned design and weigh in immediately on products so that their insights can be incorporated as the work unfolds.

We have begun to explore strategies that go beyond empathizing with students and involve students directly, with the intention of creating space for shared decision-making within foundational exercises like the root cause analysis. Including the expertise and lived experience of the intended beneficiaries of our work as co-designers and thought partners on key aspects of the work, from conceptualization to implementation to evaluation, will center the experiences, needs, and values of the students we seek to serve. Leveraging their expertise and experience not just as data points or stories, but as equal drivers of the way our problems and solutions are framed, explored, addressed, and evaluated will make our work stronger and more effective.

The root cause analysis process led to key strategic shifts in our planned work. For example, the participation of admissions representatives in the analysis highlighted the need for admissions expertise within our design and planning work. As a result, we hired an admissions expert as an external consultant to help co-lead the development of the STEM PUSH admissions strategy and created an

admissions advisory council. The council is made up of high-level admissions professionals from 11 universities who help align the STEM PUSH work with admissions realities and emergent initiatives.

More broadly, the root cause analysis provided the foundation for the development of the STEM PUSH Network's **theory of improvement** which drives and coheres its work across partners. The theory of improvement focuses on levers that can affect a subset of the identified root causes.

PCSPs are now engaged in small, iterative, small tests of change which target levers within their respective spheres of influence and agency to make improvements. For example, in the summer of 2021 PCSPs began testing a routine in which their staff engage with a podcast about racism within STEM and then discussion their own racial identities and positionality. This routine is intended to strengthen the staff members' capacity to provide culturally sustaining STEM instruction.

In addition to PCSPs testing changes, admissions professionals and STEM ecosystem leaders are designing strategic actions that address other levers in the theory of improvement. For example, ecosystem leaders began outreach to build relationships with local higher education institutions, addressing one of the conditions identified in the root cause analysis, lack of connections between PCSPs and admissions offices.

As the work progresses, the team will revisit and update the fishbone diagram and theory of improvement to reflect continuous learning about root causes and shape future actions.

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