

Visualizing the Work of Critical Transformations: Processes, Positions, and Emotions

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What does it mean to engage in equity work and critical transformation efforts? We asked mathematicians who were part of research-practice partnerships addressing inequities in their departments to create or find an image to represent what it meant to them to engage in critical transformation work. We interviewed them about their images, and categorized images in overlapping domains of the processes of critical transformation efforts, emotions, and relative positioning of members. Many participants illustrated and voiced the process of building community, which often included an inclusive power dynamic and positive and productive feelings. Images without both community and inclusivity present instead centered loneliness and discouragement. A key implication for engaging in critical transformation efforts includes the need to center building inclusive communities.

Keywords: equity, arts-based research, critical transformation, research practice partnership

Despite the values of diversity, equity and inclusion being demonized politically in the United States in 2025 (e.g., Executive Order, 2025), mathematical teaching and learning in United States K-12 and institutions of higher education do not yield equitable student outcomes, largely attributable to structural inequities and racism (e.g., Tatapudy et al., 2024; Womack et al., 2024). As part of the larger *Achieving Critical Transformation in Undergraduate Programs of Mathematics* (ACT UP) project (NSF #2201486, 2022-2025, we established a research-practice partnership with three university mathematics departments that each acknowledged their inequitable student outcomes and sought to make critical transformations to improve (Bolick & Voigt, 2023; Hagman et al., 2024; Quaisley et al., 2025).

What does it mean to engage in equity work and critical transformation efforts? We asked mathematicians who were part of research-practice partnerships addressing inequities in their departments to create or find an image to represent what it meant to them to engage in critical transformation work. We asked them about their images, and also learned about their processes and emotions. Multiple people mentioned experiencing discomfort with the request, or being uncomfortable trying to represent their work visually. However, the overall responses were positive, and people found the exercise valuable and enlightening.

One way we as researchers can challenge dominant traditions and enact critical transformations is by questioning what counts as research, rejecting reductionist methodologies that suppress individual experiences, and engaging in multiple representations of research data. As a note, we use Gutiérrez's (2012) conceptions of non-orthogonal axes of equity comprising the dominant (access, achievement) and the critical (identity, power). We considered discomfort with arts-based research (Boyd & Barry, 2024)--for those providing data and those analyzing data--to be analogous to the way we might encourage our students to embrace discomfort and struggle in learning mathematics.

Within the larger ACT UP project, mathematicians in three different departments engaged in a research practice partnership with a RUME research team, in which each department formed a

networked improvement community (NIC; Bryk, 2020; Bryk et al., 2015) comprised of faculty, students, and sometimes administrators (the community), working toward a common aim of critical transformation to address inequities (the improvement). By connecting the three NICs with the research team in a broader research practice partnership, the improvement communities could learn from each other (the network). Each NIC selected their own focus, which spanned improving coordinated (lower-division) courses, revamping placement processes, better understanding student experiences, and confronting varying assumptions about mathematical rigor. The ACT UP project launched in 2022; federal grant funding was terminated in spring 2025 by the U.S. Department of Government Efficiency. For this analysis, we focus on the research questions:

- What are the images, emotions, metaphors, positioning of self to NIC, and conceptualizations that people describe when engaging with equity-focused critical transformations?
- What is the utility of using visual imagery to make sense of critical transformations?

Methods

As part of the larger ACT UP project, we interviewed 22 NIC members and NIC leaders in early spring 2025; interviews occurred via Zoom and lasted up to one hour each. NICs were comprised mainly of mathematics instructors (faculty, graduate students), and undergraduate students; NICs had 8-13 members each. Prior to the interviews, we shared the full interview protocol and asked the interviewees to create or take a picture related to their experience of engaging as a NIC member working toward critical changes. During the interview, we then asked them, “Please describe this image - what feelings or emotions does it invoke for you?” The larger project utilized a mixture of arts-based (Boyd & Barry, 2024) and more traditional forms of data collection and analysis.

Our analysis team includes some members of the original ACT UP research team and some members of the ACT UP department-based NICs. Salient dimensions of our identities and researcher positionalities we bring to this work include being women, queer, and/or non-white in ways that are “othered” in mathematics settings; being part of families; holding university positions (e.g., postdoc, non-tenure-track, pre-tenure, administrative responsibilities); being neurospicy; and being mathematics instructors, mathematicians, and mathematics education researchers.

Our analysis team took the combination of images and explanations and used a thematic arts-based analysis process (Boyd & Barry, 2024) to tag the images with hashtags. We iteratively considered how to group and name the hashtags, and ultimately decided to group the hashtags as having to do with critical transformation processes; emotions; positioning relative to the NIC; metaphors; and other (which included mathematical connections). We used the full list of hashtags to create a word cloud (Fig. 1) to represent both the range and relative frequency of the ways we categorized images and the ways participants discussed the meaning behind the images they created or selected. We then created separate word clouds to capture the critical transformation processes (Fig. 2), positioning relative to the NIC, and emotions (latter two images omitted for space constraints). We did not create a word cloud for metaphors, as each metaphor was unique; similarly, we did not create a word cloud for the mathematical connections ($n = 2$) nor pop-art references ($n = 2$).

Findings

Our findings center the themes of engaging in critical transformations as a process, emotions, and how NIC members felt they were positioned in their NICs. Mentions of the NIC as community were the most frequent comments overall, as well as participants using metaphors, discussing connections to teaching (omitted here for space constraints), and sharing how the NIC helped them feel connected to each other (see Fig. 1). Using imagery, NIC members were able to convey the complexities and nuances of engaging in critical transformation work in mathematics departments.



Figure 1. Word cloud illustrating the relative frequency of the hashtags we applied to the images



Figure 2. Word cloud illustrating the relative frequency of hashtags related to processes of transformation

Engaging in Critical Transformations as a Process

Engaging in critical transformations is a process. For our NICs it involved establishing and nurturing collaborative communities and shared goals, making data-informed decisions, questioning systems and generating ideas, trying to make a difference or impact within their mathematics community, and reflecting on ways to change systems and navigate barriers to change across ecological levels (e.g., institutional, departmental, personal, etc.) (see Fig. 2). Many of these processes were illustrated using visual metaphors (Fig. 3). For instance, people collaborating to put together a jigsaw puzzle represents how individual ideas can fit together to form shared goals, and a guide dog represents the NIC's shared goal to guide the direction of mathematics departments, and at the same time, empower students to be puppeteers with more autonomy over their own journey within a mathematics program. As another example, one NIC member used a chaotic cloud of question marks and colorful arrows pointing in different

directions to illustrate questioning systems and generating ideas. Concurrently, this cloud hovers above NIC members engaging in systems-thinking as a process similar to deconstructing and rebuilding a brick wall.

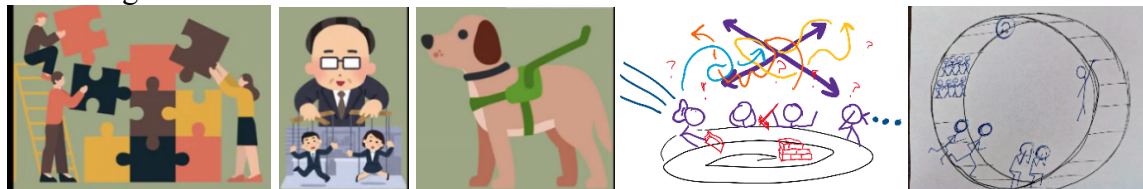


Figure 3. From Left to Right: Shared Goals as a Jigsaw Puzzle; Student as Puppeteer; NIC as a Guide Dog; Systems-Thinking as Communal Questioning, Deconstructing, and Rebuilding; and Making an Impact as a Cycle of Emotions on a Hamster Wheel.

These transformation processes were deeply connected to emotions, whether the NIC member voiced them or depicted them visually. In general, many of these processes conveyed and evoked mixed emotions. For instance, when showing or describing the process of trying to make a difference or impact within the NIC's mathematics community, some NIC members described entirely positive emotions like feeling proud, thrilled, and invested, whereas others described feeling either positive and negative emotions, such as integral, but invisible and unappreciated, or entirely negative emotions, such as discouraged, disappointed, overwhelmed, powerless, frustrated, unproductive, uncertain, lost, or confused. One NIC member specifically portrayed making an impact as running on a hamster wheel and cycling through a multiplicity of emotional states, which were both vocalized and captured in the positions and angles of the stick figures' bodies. The hamster wheel drawing in Fig. 3, depicts energized figures with elbows and knees bent to run, which transitions to worried, afraid, and shameful figures hunched over and covering their faces or dangling off the wheel with one hand. A smiley face returns the NIC member back to a state of enjoyment and fun, followed by groups of figures with arms around each others' shoulders to indicate a sense of belonging. As described in the next section, however, there were processes that consistently represented and evoked positive emotions.

Community and Belonging Fosters Inspiring, Joyful, and Accomplished Emotions

Examining the processes of transformation word cloud (Fig. 2), the relative frequency of the hashtags indicate a shared perspective that building community is one of the most important aspects of what it means to engage in the work of critical transformation. Processes of building community were conveyed through a multiplicity of media, such as real-life photographs of NIC members, including faculty and students, smiling together; AI-generated images of intently focused NIC members huddling together to make sense of and discuss data; found images of excited officemates; or mixed images of inspired NIC members generating ideas (Fig. 4). The AI-generated image and mixed image in Fig. 4 additionally demonstrate the ways in which other processes, in these cases, making data-informed decisions and generating ideas, often intertwined with images depicting a community of NIC members.

Community and Belonging Mitigates Feeling Alone, Discouraged, and Overwhelmed

A few of the images that did not center both community and an inclusive power dynamic instead highlighted feelings of being alone, alongside other negative emotions such as feeling discouraged, lost, or overwhelmed. In Fig. 5, we see an image (Starfish Students) of a young girl attending to one of many starfish spread over a beach. This NIC member described an initial and lingering feeling throughout their time on the project, stating, "I just felt so obtuse, like this was

impossible.” Although this NIC member also expressed that they felt they finally understood what a critical change was – “some sort of massive structural change within the university” – they expressed a view of limited impact, stating, “I can’t say that I pulled that off... I didn’t really necessarily pull off a big, huge structural change. But I think I made a significant impact to some students in my classes.”



Figure 4. Images Depicting Collaborative Communities.

Fig. 5 also shows an image (“No Tracks in the Ground”) of a person standing alone, proportionally smaller than the rest of the winding labyrinth-esque landscape that seemingly leads nowhere in particular. During the interview, the creator of “No Tracks in the Ground” described their process of deciding on an image. At first, the NIC member considered Sisyphus’s unending punishment of “pushing a rock up a hill in Hades and having it roll back down and then pushing it back up and then having it roll back down” but ultimately decided on “multiple, confusing paths, not knowing which way to go.” They elaborate on why they chose this image: there’s no tracks in the ground to see where anyone has gone before.. I thought people were going to tell me what to do. And now I realize that no one knows. Now I have to try to navigate. I have to pick a path and see if it brings me right back where I started, or if it brings progress... I feel alone sometimes.

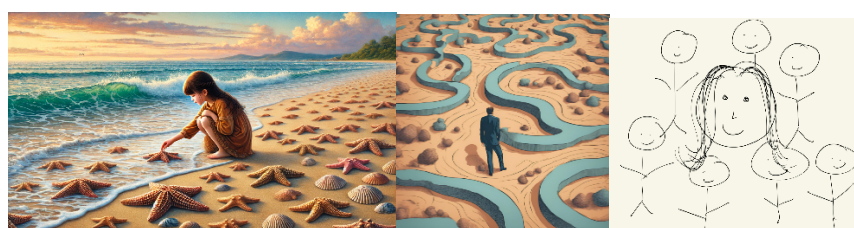


Figure 5. From Left to Right: Starfish Students; “No Tracks in the Ground”; and Community is the Best.

In contrast, NIC members who illustrated and vocalized both community and inclusive power dynamics highlighted positive and productive feelings, such as caring, motivated, and energized. Consider Community is the Best in Fig. 5, and this NIC member’s explanation for the choice of their image:

The best part of participating in this has been just having the excuse to get together with my faculty that care so much about student engagement, and are just so interested in helping their students. Those monthly meetings are just really recharging, and just a great

reminder that as you're working through issues with your students, you're not alone. There are other people that have ideas you can use, and that are experiencing the same thing. And the community is just really the best part of the whole thing.

Discussion

Asking people to create or find images to represent their engagement in critical transformations led to nuanced representations of critical transformation processes, emotions, metaphors, and relative positioning. Engaging in critical transformation work as a community was the overwhelmingly cited process captured by nearly every participant; indeed, every image that conveyed transformation processes involved people. This stance reinforces approaching critical changes systemically, and the need to do this work together. Being in community was also associated with varied positive emotions and feelings of belonging and connectedness. At the same time, when the work has a transformative aim to change systems built to maintain the status quo, people experienced mixed emotions over the slow pace of change or the barriers they encountered. Trying to make systemic changes can understandably lead to feelings of confusion, being lost, and discouragement. Feelings of community and belonging helped to mitigate feelings of isolation, discouragement, and being overwhelmed.

Schnall et al. (2008) found that people's perceptions of the steepness of a hill were altered whether they were alone (more steep) or with a group (less steep). ACT UP participants who expressed more feelings of being alone also expressed other negative emotions related to the difficulties of critical transformation work. Conversely, participants who expressed feelings of belonging also expressed other positive emotions and feelings of impact and productivity. Generally, NIC members' visual imagery of the processes of engaging in critical transformations included people, implying that these processes are people-centric and subjective, rather than an abstract process of coming to some objectively ideal conclusion. Furthermore, we found that images representing community were intimately linked to positioning and emotions. Specifically, all NIC members who centered community and an inclusive or non-hierarchical power dynamic in their images also only described positive emotions, such as motivation, inspiration, and encouragement; excitement, joy, and fun; and productivity, focus, accomplishment, and pride.

Beyond the images, emotions, metaphors, positioning, and conceptualizations, one might ask what the utility is of asking people to visually represent their critical transformation efforts. Indeed, multiple people mentioned feeling discomfort with the visualizing request, or being uncomfortable trying to represent their work visually. However, in expressing these feelings, they also expressed finding value and being challenged in a productive way through the reflective exercise. We saw ample evidence that the reflection process was useful and helpful, even when those same participants were initially uncomfortable with the task. It can be easy to focus narrowly on the "now" and not stop to see how far one has come; some participants appreciated the invitation to make sense of the process and their progress with critical transformation efforts. As researchers, moving outside the typical reflection question to an arts-based reflection enriched our understanding of how participants viewed critical transformations as a complex, difficult, and rewarding endeavor. Arts-based responses captured not only critical transformation processes but also the power dynamics of participants' positioning in their NICs as well as a wide range of emotions and metaphors.

Implications

We see several implications for researchers and for those seeking to engage (or already engaged) in critical transformation efforts. One of the key implications of this research is that

emotions and perceived power dynamics are intertwined. When a person feels alone versus feels like they belong, this is accompanied by differing perceptions of agency. Knowing that sustaining change efforts takes passionate change agents (e.g., Koh et al., 2023), such passion is more easily maintained when the change agent feels more positive emotions. Further, mathematicians rarely have training on establishing and sustaining foundational trust and professional relationships (e.g., Kaschner & Neihaus, 2025). Yet, when NICs prioritized relationship building, NIC members perceived themselves more centrally in the change efforts, which is connected to higher perceived agency and more positive emotions (all of which can sustain change efforts).

Another key implication is to expect uncertainty, confusion, and tensions. Engaging in critical transformation work is more analogous to mathematical modeling than mathematical proof or problem solving. Critical transformation works from what is known and uses data to inform next steps, but there is not a single “best” path, nor a “right” answer. There are approaches that can improve outcomes (or not), but since change efforts revolve around people (with complex identities, beliefs, attitudes, skills, knowledge, power dynamics, positional authority, etc.) outcomes are also tied to the complexities of the individuals and cultural settings involved (e.g., Hagman et al., 2024; Kezar, 2014; Kezar & Gehrke, 2015). The images selected or created by our participants expressed a wide range of emotions, including conflicting emotions from single individuals (e.g., feeling both “proud” and “unproductive”). Further, by experiencing uncertainty and confusion, some instructors found themselves more empathetic to student confusion in class (similar to findings in Tremaine et al., 2024; Quaisley et al., 2025).

Engaging in visualizing critical transformation work also helped participants consider what it meant to prioritize values like diversity, equity, and inclusion, while those concepts are under increasing political attack (e.g., Harper, 2025) and being used to stoke fears (e.g., McElvane, 2025). The visuals created by reflection on critical transformation can provide concrete evidence of how people approach critical transformation, centering student outcomes, building community, and seeking to improve educational systems and policies.

Our research highlights the importance of community. When working toward difficult goals, various emotions are evoked; people cannot change systems alone. NIC members’ modal feeling expressed through their visual depictions was that of community: being in community, feeling supported by community, and knowing they are not alone. Community is a remedy (perhaps the only remedy, e.g., García Peña, 2022) to feelings of isolation and overwhelm; community is the only way to change systems to address systemic inequities. NIC members’ experiences of community through this project showcase what it means to combat negative connotations of DEI work, centering student outcomes to transform education systems.

Finally, we do not make generalized claims that all NIC members experience critical transformation work the way those in the ACT UP project did. Rather, we use our arts-based methods (Boyd & Barry, 2024) and findings to invite others to engage in similar efforts. We suspect that many researchers focused on undergraduate mathematics education, like us, were trained in traditional (reductionist/positivist) research methodologies that position researchers as observers of participants, and research as being a way to find out “truth.” We challenge our community to seek out and try more critical methods, such as arts-based methodologies (Boyd & Barry, 2024), as ways to engage collaboration with participants in understanding unique experiences. By telling our stories, we can invite others into concomitant reflection, ideally in ways that can inspire people to initiate or expand local critical transformation efforts.

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