DISSERTATION

INVESTIGATING INDIVIDUALLY EXPRESSED MOTIVES AND COLLECTIVELY GENERATED GOALS FOR EQUITY-ORIENTED REFORM IN UNDERGRADUATE MATHEMATICS EDUCATION

Submitted By

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ABSTRACT

INVESTIGATING INDIVIDUALLY EXPRESSED MOTIVES AND COLLECTIVELY GENERATED GOALS FOR EQUITY-ORIENTED REFORM IN UNDERGRADUATE MATHEMATICS EDUCATION

Supporting diversity, equity, and inclusion (DEI) is an explicitly stated goal of many mathematics departments across the country, and addressing ongoing disparities in outcomes and experiences within undergraduate mathematics is a shared responsibility among undergraduate mathematics community members. Despite the prevalence of ideological, political, and contextual barriers to equity-oriented action within undergraduate mathematics spaces, many community members *can* and *do* take a responsive stance toward enhancing DEI within their department and at their institution. Understanding how mathematics faculty members, administrators, and students are personally motivated to take up work toward these aims within their own mathematics departments is paramount in ensuring that such work continues. In this dissertation I present two investigations which draw on cultural historical activity theory (CHAT) as a conceptual and theoretical lens. In the first investigation, I analyze the motives of 30 undergraduate mathematics community members (five administrators, 17 faculty members, and eight students) across three institutions to understand their reasoning for participation in an intradepartmental community focused on creating transformative, equity-oriented change within introductory mathematics courses. A reflexive thematic analysis of journal entries and individual interviews with participants resulted in five themes which motivated participation in collaborative equity reform within their mathematics department: a *relational* motive, a *self-*

improvement motive, a *student experience* motive, an *influence* motive, and a *values to action* motive. With these themes in mind, I then consider how a Networked Improvement Community (NIC) at one institution developed a shared object for their work through a CHAT lens, highlighting what *rules, communities, subjects, artifacts,* and *divisions of labor* proved salient to this development. The prevalence and pervasiveness of self-interest, identity neutrality, and paternalism are critically discussed within the context of these investigations, and I build on existing literature to produce recommendations for disrupting such ideologies to produce transformative change in undergraduate mathematics environments. Among these recommendations are the need for *critical engagement* to see beyond self-interest in the context of one's own reform work, and the need for collaborative reform groups to not only position *students as experts* on their own experiences, but to also conceptualize *instructors as novices* on student experiences. I conclude with a discussion of future work supporting continued theorizing of the link between individually expressed motives and collectively generated goals in undergraduate mathematics reform efforts.

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Thank you to you, the reader, for engaging with this work. I extend to you the hope that you find among your communities the strength of support and encouragement which I am so grateful to know.

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CHAPTER 1: INTRODUCTION

This dissertation began with a question. Unlike most dissertations, this was not a question asked by myself, the researcher, but a question asked by an audience member at a talk my advisor gave several years ago. The talk was in reference to a recent publication, Tremaine et al. (2022), in which we developed an evidence-based taxonomy for understanding the perspectives of calculus instructors, administrators, and students with regard to why it is important to increase diversity in STEM fields. Drawing on the work of Gutiérrez (2002; 2009) and Basile and Lopez (2015), we considered who was positioned as the principal beneficiary of increased diversity in STEM (STEM industry, academic institutions, STEM students, or families and communities) and whether this positioning upheld existing structures through attention to access and achievement or recognized the need to dismantle and re-envision those structures through attention to identity and power.

My advisor's presentation was one of the first avenues at which we publicly shared our findings from this work. She discussed our taxonomy, explaining the various reasonings for increasing diversity which we had observed through the interviews and focus groups we conducted. After the presentation, one audience member raised his hand and posed a question: "What about increasing diversity just because it's the right thing to do?" To this audience member's point, increasing diversity "because it is the right thing to do" does not have a clear place in the taxonomy developed in Tremaine et al. (2022). My advisor, Dr. Jess Hagman, brought this question to the rest of the Tremaine et al. (2022) writing team: myself, Dr. Matt Voigt, Stephanie Damas, and Dr. Jessica Gehrtz, and together we worked toward dissecting this perspective. While we certainly made explicit in Tremaine et al. (2022) that our taxonomy was

not intended to be exhaustive, this audience member felt we had overlooked a fundamental component of how stakeholders may reason about the importance of increasing diversity within STEM. In this conversation amongst ourselves, we theorized that increasing diversity as "the right thing to do" could have many beneficiaries; we asked ourselves the question of "for whom" was it the right thing to do. There were many ways to answer this question aligned with our Tremaine et al. (2022) taxonomy. However, as our conversation developed, we became aware that perhaps there was a category of stakeholder who could benefit from increasing diversity whom we had overlooked in our taxonomy: the *self*.

Framing increasing diversity as the right thing to do could be an opportunity to feel good about oneself. Increasing diversity could provide an opportunity to enact, or be a part of an environment which enacts, a held value that one feels for the importance of bringing more representative voices into STEM spaces. Consider the following quote from Hart (1974) in which they consider the moral rightness of working toward enhanced diversity, equity, and inclusion (DEI) through public administration:

> The more advantaged have *a moral duty to themselves* to deploy their talents in the service of the least advantaged and a moral obligation to do so because they have fared so well in the natural 'lottery' or in the social arrangements. (p. 8, emphasis added)

Notice that the duty is not to an external population, but is conceptualized as being a duty to *oneself*. Conceptualizing increasing diversity as the right thing to do could be a way to achieve moral alignment; founded in a life philosophy of what is *right*, the opportunity to see that *rightness* enacted provides great gratification for the self. Increasing diversity may also be an opportunity to feel a stronger sense of belonging toward one's discipline through increasing the propensity of shared life experiences, perspectives, or values within a cohort. Perhaps, more

critically, seeing diversity increased within STEM could be an opportunity to ease the guilt one might feel from being involved in a system in which folks with certain social identities are consistently marginalized (Howard, 2011). This line of conversation prompted me to think more deeply about the ways in which self-interest may weave itself into equity work–work which is often conceptualized in dominant spaces as being purely moral or altruistic.

Scholars have articulated the *moral imperative* of working toward equity, particularly as it relates to increasing access to STEM fields (Apkarian et al., 2019; PCAST, 2012). Framing equity work as moral is not novel, and indeed some argue for a greater explicit acknowledgement of the moral and ethical dimensions of reasoning for pursuing DEI in the higher education context (Deem et al., 2005). Others argue that the moral imperative for the pursuit of equity is relatively weakly justified (Bull, 2012) or lacking philosophical underpinnings that could strengthen the efficacy of institutional DEI initiatives (Cook & Taff, 2022). This study does not make claims as to a baseline ethical or moral imperative of equity work in higher education, but I introduce this notion of a moral imperative, and the consideration of potential self-interest which accompanies it, as a springboard for criticality in investigating the motives with which equity work is performed.

Considering critically whose interests are centered in the reasoning for equity-oriented educational reform is a line of inquiry that has been explored by scholars for decades. At the K-12 level, critical analyses of STEM education policy documents produce productive critique of how students of color are positioned and essentialized in such documents (Basile & Lopez, 2015) and how the rhetoric of national mathematics education reform can center white and capitalistic interests and decenter interests of the marginalized students and communities such reforms claim to serve (Berry, 2018; Martin, 2003). Secada (1989) considered the reasoning for equity reform

with regard to the participation of folks with marginalized identities in mathematics education, noting that this reasoning reflected the perspective that

> It is in the self-interest of this country to invest its resources in creating human capital within those groups for whom it is lacking. It is in our *enlightened self-interest* to invest extra time and resources in order to ensure the adequate mathematics preparation of this country's girls, non-White/non-Asian minorities, and children from lower SES backgrounds. (p. 26)

Secada profoundly problematizes what they define above as *enlightened self-interest*, arguing that it reinforces deficit perspectives on students with marginalized identities, does not provide a proactive path for the meaningful consideration of marginalized perspectives in reform, and maintains marginalizing ideologies around education and employment. Secada ultimately argues that equity reform in mathematics education and enlightened self-interest should be kept distinct, conceding that calling attention to issues of equity is an important function of enlightened self-interest, but that "notions of human capital as elaborated in the form of enlightened self-interest are simply not adequate for the task" of enhancing equity within mathematics education (p. 48).

Critical analyses such as these are fundamental in revealing how oppressive ideologies prevail even in the context of equity-oriented reform, and thus are foundational in challenging policymakers to more deeply consider whose interests are centered when drafting or advocating for reform in mathematics education. However, federal policy documents are less often used to regulate undergraduate mathematics spaces– policy and practice are often localized to particular universities and departments. Understanding individuals' personal motives for engaging in equity-oriented work is one way to gain insight into whose interests are centered in equity-oriented reform in undergraduate mathematics education spaces. Informed by the conversation

with the Tremaine et al. (2022) writing team, I critically considered my own motives for engaging in equity-oriented research work. While I find myself unable to separate my reflections on this topic from the Tremaine et al. (2022) framework, I also can conceptualize ways in which I center my own interests within the work I do. One particular dimension is exemplified by the document you are presently reading. Conducting equity-oriented research will enable my attainment of a Ph.D., which will provide me with an opportunity to work in an academic field that I find personal fulfillment in, and will provide my family and I with additional income security through increased career opportunities.

Further, similar to Hart's (1974) assertion, I feel that the privilege afforded to me as a white, cisgender, non-queer mathematician who achieved traditional markers of success in mathematics spaces places upon me a responsibility to leverage my power in these spaces in meaningful ways, and my research is one dimension of how I try to leverage that power for social good. I hold deep beliefs about the importance of DEI efforts within undergraduate mathematics spaces, informed by my own experiences, the experiences of others, and my scholarly readings on the topic. However, such beliefs exist as motivating factors alongside motives which clearly center my own personal fulfillment or perceptions of responsibility. Informed by the findings of Howard (2011), I've realized that positioning myself as a socially responsible and continually growing agent of change in undergraduate mathematics spaces provides self-justification for my continued career growth in a way which blends self-interest with a desire to see more equitable spaces realized in undergraduate mathematics. This does not mean that I shouldn't continue to use my growing power in this space to support more equitable environments, but does call in an additional dimension of my own motives which I need to be aware of and enact responsibly. In proposing this dissertation, I sought to build on the work of

Tremaine et al. (2022) in a way that enhanced understanding of the personal dimensions of reasoning for DEI work, and began theorizing around the ways in which motives–and who is centered within them–impact equity work in undergraduate mathematics education spaces.

This began with shifting the question; instead of investigating why undergraduate mathematics program stakeholders felt DEI should be enhanced, as we had in Tremaine et al. (2022), I wanted to know why undergraduate mathematics program stakeholders personally worked toward enhancing DEI at their institutions. Apkarian et al. (2019) found that, while mathematics program stakeholders are aware of the importance of DEI to the ongoing success of the discipline, "there was an underappreciation of the extent to which action taken within the mathematics department can make a difference to these students" (p. 23). Instead, undergraduate mathematics faculty and administrators considered support for marginalized students to be a responsibility of the institution. While institutional supports, such as student affairs offices, DEI offices, and student ability centers are valuable partners in addressing DEI issues within a mathematics department, there exists a need for introductory mathematics programs to explicitly take ownership of DEI issues (Apkarian et al., 2019; Hagman, 2019). Larnell (2023) issues the following call to the undergraduate mathematics discipline:

> The responsibility for redressing these deep inequities should not be relegated to a small, impassioned group of reformers but shared by the entire community of faculty members and academic researchers who steward the undergraduate mathematics education corridor (p. 1).

In addition to promoting responsibility for addressing DEI issues within mathematics departments and among undergraduate mathematics education practitioners, the recognition of enhancing DEI as a shared responsibility requires calling in additional mathematics program

community members (Doten-Snitker et al., 2021). Undergraduate mathematics community members form the foundation of department efforts toward equity; in particular, they would inform the direction of reform using their own knowledge and experiences. The goals that they develop in relation to equity at their institutions will then shape progress. Thus, understanding how such goals develop (and how those goals interact with the motives they originally bring into equity reform) is an additional relevant component of responding to this call of shared responsibility for working toward equity.

Scholars have empirically shown that there is room for critical growth in undergraduate mathematics community members' understandings of equity and equity issues (e.g. Apkarian et al., 2019; McNeill et al., 2022; Tremaine et al., 2022). Responding to Larnell's (2023) call and treating the redressing of inequity as a shared community responsibility remains far from the dominant discourse within the field. Despite the ideological barriers posed by dominant discourses, undergraduate mathematics stakeholders *can* and *do* take up equity work as an important component of their roles. This includes adopting justice-oriented and humanizing pedagogies (e.g., Alexander et al., 2019; Ching & Roberts, 2022) and taking up departmental collective action toward equity-oriented change (e.g., Noble et al., 2021; Corbo et al., 2015). There is much to be learned from folks who are presently choosing to be involved in equity work in undergraduate mathematics; Alzaga Elizondo and Larsen (2024) write, "to develop initiatives that center and support marginalized students, it is also important to examine the stakeholders leading the charge" (p. 6). This study undertakes such an examination by considering the motives which bring folks to such spaces of action, and considering what is salient to their collectively generated objective for their work. Tuters (2017) writes that

> One way of…contribut[ing] to the sustainment of existing equity work, and to encourage the development of new equity workers, is to learn more about the reasons current educators have for teaching for equity, and what they think attributed to their development as equity minded individuals. (p. 50)

While studies have looked at various ideological traits or contextual resources of educators which inform participation in equity work (see, for example, Aragón et al., 2016; Nadelson et al., 2022; Woodcock & Woolfson, 2019), few have explored the explicit or implicit *motives* of higher education stakeholders for partaking in such work. This study begins addressing this gap in the literature, in the context of introductory undergraduate mathematics. The documented disparities in experiences and outcomes which exist in precalculus and calculus spaces make this a particularly pertinent context for such an investigation (Battey & Leyva, 2016; Battey et al., 2022; Ellis et al., 2016; Hagman, 2019; Leyva et al., 2020). Undergraduate mathematics community members' recognition of the value of DEI within mathematics departments (Apkarian et al., 2019; Tremaine et al., 2022) alongside powerful calls to take up such work within the discipline (Hagman, 2019; Hauk et al., 2021; Larnell, 2023) make understanding the personal motives of mathematics program stakeholders for working toward equity foundational for understanding more about the actionable ways in which folks respond to such shared valuation of DEI and disciplinary calls to action.

Particularly as several states pass legislation aimed at limiting or outright banning DEI efforts in higher education institutions (The Chronicle of Higher Education, 2024), it is increasingly important that department members are personally taking up the call of DEI work so that such work toward more equitable futures can continue. Following Tuters (2017) assertion, understanding what brings stakeholders into these actionable spaces can sustain and encourage

equity work. However, this must be done with a critical eye; Martin (2019) writes that "the forms of inclusion offered up in equity-oriented discourses and reforms within mathematics education have typically involved two trajectories: (1) inclusion accompanied by marginalization, and (2) assimilation into the existing cultures of mathematics education" (p. 461). The discourses Martin points to are further evidenced by the work of scholars who assert that education reform for racial equity and its associated progress exclusively take place when white interests are served (Bell, 1980; Berry, 2018). Understanding whose interests are centered in personal motives for equity work among mathematics program stakeholders is an initial step to investigating how these discourses might manifest on a personal level. More broadly, connecting individual motives to the collaborative action plans undertaken by mathematics faculty, administrators, and students may yield insight into how personal motives can contribute to or hinder local institutional or departmental progress toward addressing inequity. In order to investigate these components of equity work within undergraduate mathematics education, I present two parallel investigations in this dissertation:

- *In what ways do undergraduate mathematics instructors, students, and administrators motivate their participation in an equity-oriented networked improvement community?*
- *What are the salient features which mediate mathematics instructors' and students' collective generation of a shared object for equity-oriented reform?*

Both of these investigations take place in the context of the ACT UP Math project (NSF EDU #2201486), allowing for a cohesive environment in which to study what brings individuals into collective reform work, and how their goals are collectively developed and refined to come to a shared objective for the work.

In the following chapter (Chapter 2), I provide a literature review focused on relevant work within mathematics education and within the study of higher education more broadly. This literature encompasses understandings of motives for activism and professional development. Notably, the ACT UP Math project is not explicitly a professional development opportunity nor an explicitly activist effort; instead, it is an amorphous collaborative equity-oriented reform effort, and thus I find it prudent to pull literature centering motives for various types of equity-oriented work in undergraduate spaces. Following this literature review, Chapter 3 contains an overview of the ACT UP Math project, a description of cultural historical activity theory (CHAT; Engeström, 1987; 2001) as a guiding conceptual framing for this work, and a reflexive positionality statement.

The first investigation (Chapter 4) considers journal entries and individual interview data from 30 participants across three institutions. I leverage reflexive thematic analysis (Braun et al., 2023) to construct five themes which faculty, students, and administrators express as motivating their participation in an equity-oriented networked improvement community. *Relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives are discussed and defined as they relate to participants' data. These themes were then presented back to participants, and they were given the opportunity to reflect on their resonance (or lack thereof). These themes both reflect and build upon themes found in previous literature on motives for activism, and are discussed critically with regard to what they tell us about how equity work is conceptualized by stakeholders in undergraduate mathematics education, and whose interests are centered within these individual motives.

The second investigation (Chapter 5) is a mini-ethnographic case study (Fusch et al., 2017) which centers a conversation at Kappa University (KU) in which members of a NIC

participate in the shared development of the *object* (or, collective motive) for their NIC's work. This conversation is contextualized with field notes, meeting notes, journal entries, and interviews from myself as a direct observer and from members of the NIC to paint a holistic picture of what kinds of rules, artifacts, communities, and divisions of labor the NIC drew from in service of creating a shared object. Implications are provided for constructing effective decision-making spaces toward DEI progress, as well as specific features of the data which lend themselves to further critical investigation.

Finally, Chapter 6 considers connections between the two investigations, with the intention of beginning to theorize the relationship(s) between personal motives and collectively generated goals for equity reform within undergraduate mathematics departments. I draw on literature connecting individual and collective activity to consider the two investigations and articulate opportunities for future work.

CHAPTER 2: LITERATURE REVIEW

I situate this study of motives and goals within several areas of literature from both undergraduate mathematics education scholarship and higher education scholarship more broadly. In this literature review, I begin by providing an overview of how undergraduate mathematics community members–principally faculty–respond to the need to enhance DEI in undergraduate mathematics, and various ideological and contextual experiences associated with taking action toward enhancing DEI within higher education. I then elaborate on literature focused on motives for reform within undergraduate education spaces, both through activism and through professional development. I conclude by considering perspectives which connect personal motives to collective norms and actions.

Enhancing diversity, equity, and inclusion (DEI) in mathematics education is a topic of increasing interest in mathematics and mathematics education spaces (Apkarian et al., 2019; Crespo et al., 2022). With greater attention paid to the ways in which students differentially continue through introductory undergraduate mathematics based upon social identity markers (Ellis et al., 2016; Seymour & Hunter, 2019), mathematics departments have become a central area of focus for reform in undergraduate mathematics education. While the reasoning for reform often centers a national economic or globally competitive imperative to ensure that a greater diversity of individuals are entering the STEM workforce (see, for example, PCAST, 2012; National Science & Technology Council, 2021), an increasing body of work has advocated for reform which attends to the differential experiences of students within undergraduate mathematics classrooms. With the knowledge that racialized and gendered ideologies manifest in undergraduate mathematics learning spaces (McGee & Martin, 2011; Rodd & Bartholomew,

2006), scholars have turned attention to not only quantitative disparities in precalculus and calculus courses, but also how these courses are differentially experienced by students who hold marginalized identities (e.g. Apkarian et al., in press; Battey et al., 2022; Leyva, 2016; Rios, 2023).

The work of Apkarian and colleagues (2019) demonstrates that mathematics instructors and administrators experience a lack of agency toward addressing these disparities within their professional roles. Dominant discourses in mathematics continually position undergraduate mathematics education and instructional events as race- and gender-neutral (McNiell et al., 2022), and discussions about enhancing DEI largely center support for increasing access and achievement within existing educational systems, rather than critical consideration of how enhancing students' power or attending to student identities may inform re-envisioning such systems (Tremaine et al., 2022). Further, activities toward enhancing DEI are not often professionally incentivized within academia (Jauchen, 2024) and are predominantly undertaken by women faculty members and faculty members of color, although STEM environments are frequently dominated by white male faculty (Jimenez et al., 2019). As such, addressing issues of DEI remains one of the most "perplexing challenges facing higher education" (Ching, 2018, p. 414). Understanding this challenge in the context of undergraduate mathematics education necessitates contending with the personal agency felt by undergraduate mathematics community members, as well as discourses which maintain neutrality and uphold current marginalizing systems.

Simultaneously, many members of undergraduate mathematics education communities *do* choose to take an active and responsive stance to issues of DEI in this field (Voigt et al., 2023). Some of these actions take place in instructional settings; for example, MacArthur (2023)

describes a personal account of an instructor making changes in a calculus course to better center Gutiérrez's (2018) notion of rehumanizing mathematics for Black, Latiné, and Indigenous students in her calculus classroom. Erskine et al. (2022) and Zambrano (2018) consider implementations of social justice oriented lessons in a precalculus and calculus class, respectively, with particular focus on how such lessons impacted student experience. The development of tools such as EQUIP (Reinholz & Shah, 2018) have enabled undergraduate mathematics instructors to self-assess in critical and productive ways that inform their practice (e.g. Stone-Johnstone et al., 2023). Beyond individual action, mathematics departments and other institutional groups take responsive stances to issues of DEI in introductory undergraduate mathematics. For example, Zobitz et al. (2023) shifted the curriculum, pedagogy, structures, and support systems around their calculus course to better support students of color in their program. DiGregorio et al. (2023) focused on shifting messaging around mathematics placement in a large department, resulting in increased placement completion by students of color, first-generation students, and Pell-eligible students. I further emphasize that many undergraduate mathematics education community members work toward equity at their institutions in ways not documented by traditional scholarly research. At both the individual and departmental level, some mathematics program stakeholders are choosing to take action toward enhancing equity in introductory mathematics at their institution.

Learning from and with others in professional development or collective action settings can provide a foundation for equity-oriented change processes. Consider Dowd and Liera (2018) who studied the progress made by faculty members engaged in cycles of inquiry around organizational data, finding that sustained change for racial equity was supported by iterations of such inquiry. Bringing together faculty, administrator, and student community members,

Sidman-Taveau and Hoffman (2019) described the efforts of a committee to address achievement disparities for Black and Latiné students in California community colleges through a variety of collaborative projects. These projects included incorporating the principles of equity-mindedness to construct supports for students living off-campus, creating welcoming counterspaces for undocumented members of the campus community, and making course registration a campus-wide event at which students can be supported in navigating the registration process, with specific focus on supporting students for whom English is a second language. An additional example of collective work toward equity comes from Noble and colleagues (2021) in which they implement a Networked Improvement Community (NIC) structure amongst faculty from different universities to increase the number of graduate students who are interested in faculty careers, with an explicit emphasis on growing the number of Black, Latiné, and Native scholars pursuing faculty careers. Their NIC considered many different approaches across institutions, many of which were built on partnerships with existing on-campus organizations. These types of collective efforts, which tackle issues beyond the department level, also serve to actively support enhancing DEI at institutions.

Reinholz and colleagues (2020) recently put forth a call to expand the literature base focused on studying change in undergraduate mathematics education–particularly, change which goes beyond individual efforts. In concluding this call, they write that

> At this moment in time, there are changes within mathematics education that are happening and that need to happen. There is an important role for the RUME community: its scholarship can equip those who would initiate, shape, and implement these changes. (p. 155)

This work aims to contribute to this call by furthering our understanding of what brings undergraduate mathematics community members into places of making change toward equity, and understanding how they come together to create a shared objective for their equity-oriented work. With the recognition that research in undergraduate mathematics education has a "long history of drawing from other fields to achieve its goals" (p. 155), I root this work in literature from higher education scholarship and scholarship in K-12 spaces to articulate relevant understandings of what motivates folks to engage in equity-oriented work in undergraduate mathematics, as well as how those motives may connect to collectively generated goals.

2.1: Ideological and Contextual Factors Associated with Action

In considering what factors lead individuals in education to pursue equity reform in their own practice or in collective groups, the espousal of ideological or cognitive frames has proven relevant. Aragón and colleagues (2016) found that faculty members who expressed a multicultural ideology–one which explicitly recognized and celebrated multicultural components of teaching and learning–were more likely to implement inclusive teaching practices in their classrooms than those who espoused a color-evasive ideology, which is defined by race-neutral language and avoidance of the challenges faced by specific groups in undergraduate settings. Considering that race- and gender-neutrality in mathematics instruction is a dominant discourse among undergraduate calculus instructors (McNeill et al., 2022) and that STEM faculty more broadly tend to not recognize the racialized nature of anti-Black classroom events (King et al., 2023), Aragón and colleagues' finding holds particular significance for introductory undergraduate mathematics education spaces.

Equity-mindedness is another ideology associated with the potential for taking action toward equity reform. Equity-mindedness, also called an education equity mindset, is "a set of

perceptions and motivations that lead to actions aligned with how individuals perceive equity situations in education" (Nadelson et al., 2022, p. 60). As conceptualized by Bensimon (2018), equity-mindedness is demonstrated through (i) being color-conscious and critically noticing and questioning differential experiences, outcomes, and degrees of inclusion for students with marginalized identities, (ii) acknowledging that racism stems from practices which are normalized by dominant society, and questioning dominant discourses behind such practices, and (iii) being aware of the (often unintended) impact of one's own positionality, and the racialized beliefs, expectations, and practices that accompany one's identities. Nadelson and colleagues (2022) describe education equity mindsets as existing on a spectrum, from a *weak* equity mindset to a *strong* equity mindset (shown in Figure 1).

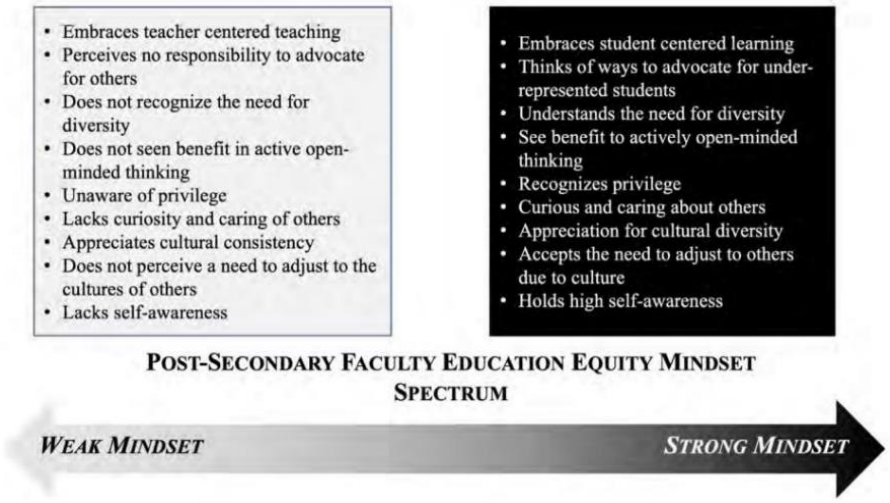


Figure 1. The Education Equity Mindset (Equity-mindedness) Spectrum (Nadelson et al., 2022, p. 61).

Equity-mindedness is consciously cultivated (Bensimon, 2018) and performed differentially depending upon social context, extent of knowledge, and current emotion (Nadelson et al., 2022). Nadelson and colleagues (2022) also found equity-mindedness to be more readily accessible to faculty members with certain social identities. Within a gender binary,

they observe that women faculty members expressed stronger equity-mindedness than men faculty members, and that faculty who taught greater numbers of students, as well as faculty who taught STEM courses, tended to espouse weaker equity-mindedness. This has significant implications for mathematics education, particularly within precalculus and calculus courses, as those are STEM courses which tend to have larger class sizes. Nadelson and colleagues assert that a strong equity mindset correlates with the extent to which undergraduate faculty feel personal responsibility for enhancing DEI, and thus their likelihood of being actively involved in equity reform at their institution.

The notion of such a correlation between personal responsibility and likelihood of action toward equity is paralleled in other work at the undergraduate level. Idahosa and Vincent (2019) assert that faculty members who are capable of seeing beyond self-interest and engaging in transformative equity reform at their institutions embodied four characteristics when discussing issues of DEI: disrupting comfort, apprehending the natural as strange, imagining a different order of things, and engaging in reflexivity. Idahosa and Vincent contend that, although faculty members experience relative comfort in their privileged positions within academia, these characteristics enable them to transform their own interests in ways which motivate them to "contribute to the transformation of university structures, relations, and practices" (p. 783).

Alongside these ideological adoptions, faculty members need systemic support in order to make shifts toward inclusive teaching practices (Woodcock & Woolfson, 2019). In the K-12 setting, Gitschthaler et al. (2021) found that instructors' perceptions of resources available to them as they considered inclusive teaching practices were salient to their decisions to implement such practices. Tuters (2017) also found that teachers' choices to engage in equity work was a result of personally experiencing inequities, witnessing inequities, and learning about inequities

through education. In these cases, perceptions of supportive resource availability and experiences around inequity serve as cognitive resources that prompted instructors to act toward enhancing equity at their schools.

This body of scholarship contends that, "under the right conditions, institutional actors will strive to learn how to change themselves and their one institution to produce equity in educational outcomes" (Felix et al., 2015, p. 25). This is a promising and hopeful view, one which is at the core of this dissertation: that undergraduate mathematics community members willingly choose to be involved in such reform to collectively shape their academic environments in ways which promote more equitable experiences and outcomes. This view is accompanied by the knowledge that, despite the increase in DEI-focused rhetoric and scholarship in recent decades, equity-oriented reform has been incremental and has often failed to serve the populations which it professes to center. Bensimon (2018) describes two threats which face aims of racial justice in higher education:

> One [threat] is the total omission of race and whiteness in national higher education reforms that endeavor to move the college completion needle higher–towards some definition of success that is defined primarily by graduation rates. The second threat is the co-optation of equity and the erosion of its racial justice agenda. (p. 96)

These two threats parallel concerns expressed by other researchers: that DEI-focused reform, left uninterrogated, will naturally conform to dominant ideology, and thus its effectiveness in terms of creating true structural reform which centers marginalized folks and communities– especially with respect to race–will be diminished. Martin (2019) asserts that "forms of inclusion offered up in equity-oriented discourses and reforms within mathematics education have typically involved two trajectories: (1) inclusion accompanied by marginalization; and (2) assimilation into the

existing cultures of mathematics education" (p. 461). Neither of these forms of inclusion enable systemic change to mathematics environments, and thus do not create meaningful, disruptive, or emancipatory change for students traditionally marginalized in mathematics spaces.

Centering the Critical Race Theory (CRT) tenant of *interest convergence* has led scholars to important critical observations around educational reform for racial equity. Interest convergence is the concept that educational reform for equity and its associated progress exclusively take place when white interests are served (Bell, 1980; Berry, 2018). Berry (2018) observes that equity reform in mathematics is often motivated by national economic interests, and asserts that "a consequence of this framing is that participation in mathematics education is based on ensuring that the dominant culture's economic, technological, and security interests are met rather than addressing the needs of learners" (p. 19). One recent example of the commodification resulting from such a positioning is the recruitment and retention of Black mathematics teachers as a means to meet diversity requirements or achieve racial matchings between instructor and student populations without significant attention paid to the needs of those Black mathematics teachers, or any work to mitigate the microaggressions and racism that contribute to thoughts of leaving the teaching profession (Frank et al., 2019). Commodification of individuals with marginalized identities is also present in the discourses of national mathematics and STEM education policy documents (Basile & Lopez, 2015; Ellis, 2008; Martin, 2003). In these ways, reform for equity has fallen short of the ideational goal of centering the needs of marginalized students and communities, often in service to dominant (white, patriarchal, capitalistic) interests.

Scholars point toward investigating motivating factors of reform as one avenue to critique and advance the ways in which equity reform can better center the perspectives and needs of

marginalized populations (Berry, 2015). Lewis & Shah (2021) note that investigating the rationale behind purported equity reforms can also ensure that reforms extend beyond quantitative diversity. This dissertation aims to investigate motives and goals on both the individual and collective level, providing critique around whose interests are being served and how such goals are developed. Such critical examinations are not intended to produce arguments for ceasing to work toward equity, but rather illuminate ways to reduce harm and commodification by aligning equity reforms with the interests of marginalized populations.

Motives for Activism and Professional Development in Higher Education

As evidenced by the literature above, impetuses for partaking in equity reform in higher education have mostly been studied as consequences of ideologies (such as equity-mindedness) or as consequences of context (such as personal experiences). While these are undoubtedly important dimensions of individuals' decisions to take action toward enhancing equity, I am interested in understanding the motives individuals express to reason about their own participation in equity reform. My definition of *motive* is rooted in cultural historical activity theory (CHAT), which will be detailed in Chapter 3. CHAT defines a motive as a goal, desire, or rationale which "guide[s] the reason for doing the activity, and the organization of the activity itself" (Núñez, 2021, p. 12). Within this literature review, "the activity" in question is engagement in collaborative equity-oriented reform. The ACT UP Math project does not clearly fit into previously investigated activity types, such as professional development or activism, but rather exists amorphously as a collaborative equity-oriented reform effort. As such, I draw from literature on motives for multiple types of collective activities within higher education spaces.

I begin with a discussion of motives for activism in higher education. The most prominent way in which motives for activism are studied in higher education contexts is focused

on university students. For example, Gibson & Williams (2020) considered the motives of students at an HBCU to participate in a protest following the Jena Six convictions (in which six black teenagers convicted on severe charges for the beating of a white student, highlighting racism around how severely black youth are charged compared to their white peers). They found that students were motivated to participate due to perceptions of the protest as a way to "take a stand" through collective action, by prior knowledge of the history of social justice movements, and through self-identification either with the victims or with the cause of racial justice. Notably, they also observed a gendered difference in motive, in which women students expressed a greater future orientation in motivating their activism work (i.e. seeing the work as something which would benefit future generations), and that men tended to express more self-identification motives in their decision to participate in the protest. With regard to the Black Lives Matter movement, Oljirra (2021) notes the importance of the moral imperative of activism work, relating to values like freedom or an awareness of racially unjust systems, as a motivating factor for university students. In considering the perspectives of affluent college students for participating in social justice efforts, Howard (2011) found that their motives centered around responding to feelings of guilt associated with their privilege, understanding themselves as a resource for change, and the social and cognitive rewards of engaging in such work. Building upon this finding with attention to racial privilege specifically, Dull and colleagues (2021) observed that, among college students, the correlation between white guilt as a motive and anti-racist civic action was mediated by feelings of social responsibility and civic efficacy; high social responsibility and civic efficacy enabled meaningful transformation of white guilt into anti-racist action. Each of these studies considers a different context to paint a picture of how university students motivate their participation in activism.

University faculty members are also meaningfully involved in creating and sustaining activism at institutions and in society more broadly (e.g., Kornbluh et al., 2019); however, activism often remains devalued within academic structures (Rose, 2017). The motives of faculty members for entering spaces of activism are less often explored. In a rare example of such an exploration, Kezar (2010) investigated the motives of faculty and staff for partnering with student activists at three differentially classified US campuses: a small liberal arts campus, a community college, and a large research university. Common to all three institutions was developing future leaders as a motive for partnering with students to create change. Faculty and staff members at the liberal arts and research institutions also referenced student energy and enthusiasm for change as a motive for engaging in such a partnership. Faculty and staff members at the community college and liberal arts institution viewed their own backgrounds in activism as motives for such partnerships with students. Kezar emphasizes the importance of institutional context to investigate motives for faculty and staff members' partnerships with student activism groups.

Scholarly investigations in the motives of faculty members for participating in professional development (PD) are also informative to this dissertation study. Contemporary investigations of motives for faculty engagement in professional development tend to focus on pedagogically-oriented PD, with little inquiry in the way of motives for participation in equity-oriented PD. Bouwma-Gearhart (2011) found that STEM faculty at research universities engaged in pedagogically-focused PD for three primary reasons: a desire to build connections with other faculty members interested in improving their teaching, increasing their own instructional competence, and enhancing the comfort they felt around their own professional autonomy. Bouwma-Gearhart considers these motives as addressing three key needs of faculty members at

research universities: a need for social relations, a need for pedagogical competence, and a need to feel comfortable in autonomy. Lowenthal and colleagues (2013) ask a similar question, focusing instead on the extrinsic motives of faculty across different institution types for participating in instruction-focused faculty development. They considered extrinsic factors such as the availability of course releases and department documentation of development attendance. They found that receiving a stipend was most motivating among both part-time and full-time faculty, with full-time faculty having an additional strong motivator from the availability of course release opportunities for participation. Evidence from Hardré (2012) indicates that intrinsic and value-focused motives are, however, more salient for faculty members' participation in professional development than extrinsic or contextual factors, drawing from the perspectives of community college faculty. This is further supported by findings in the K-12 space, in which Mintrop and Ordenes (2017) determined that material incentives (such as monetary bonuses or organizational recognition) were less salient to individuals' motives for teaching at social-justice-oriented public charter schools than were pro-social commitments and self-identification with the work.

I'd like to take a moment to trouble the binary set forth by intrinsic and extrinsic motivations. This is a common way of classifying motives, both colloquially and in the literature. While *extrinsic* motives focus on reward attainment from external sources (such as praise, financial benefits, or grades), *intrinsic* motives are framed as being "satisfaction derived from the action itself" (Covington & Müeller, 2001, p. 164). The two types of motivation are commonly considered to be antagonistic, and this positioning is upheld in most work which leverages the two constructs (Covington & Müeller, 2001). However, considering intrinsic motives as existing without external influence ignores the social, cultural, and historical contexts through which

those motives developed and may be performed differently in different spaces. Conceptualizing extrinsic motivations as disconnected from more internal processes also reduces the inherent complexity of human action toward external rewards. I argue instead that there is frequent interplay between the two dimensions. Consider Bouwma-Gearhart's (2011) finding that faculty are motivated to participate in professional development in order to build social connections with other faculty members. This motive is not self-contained within the participating faculty member; this is not an instance of them participating in professional development for the satisfaction of professional development themselves. Building connections with others is necessarily extrinsic to oneself. There is external social validation from forming positive connections with others and having meaningful, uplifting, interesting interactions. Simultaneously, a desire for social connection is also inherently intrinsic, through the development of a sense of belongingness to a community or a feeling of personal validation through social relationships. To name this complex motive as either extrinsic or intrinsic is inauthentic. Bouwma-Gearhart themself recognizes a need to "acknowledge that [intrinsic and extrinsic motivations] intersect in most human realities" (p. 560). I provide this argument to frame why I do not move forward with considering the intrinsic versus extrinsic motives expressed by undergraduate mathematics community members, but rather treat all motives as perspectives which hold varying degrees of intrinsic and extrinsic dimensions, and do not centralize this distinction in my investigations although it is colloquially common to discuss motives in these terms.

Bess (1997) instead proposes a classification of interrelated "realms" of motives for faculty members: influence stemming from the self, from the local department or university, and from the wider societal system of higher education. Motives might also be classified based upon

whose interests they center. Tremaine and colleagues (2022) dissected the reasoning of calculus stakeholders for why it was important to increase diversity in STEM spaces. These perspectives resulted in the Framework for STEM Diversity Perspectives (Table 1), which juxtaposed and adapted existing work from Gutiérrez (2002; 2009) and Basile and Lopez (2015) to create a nuanced taxonomy of reasoning for increasing diversity in STEM.

Table 1. Framework for STEM Diversity Perspectives (Tremaine et al., 2022)

	Dominant Perspective	**Critical Perspective**
Economic and entrepreneurial benefit to the STEM enterprise	Bringing in diverse perspectives will help solve existing problems and answer questions that already exist in STEM industries	Bringing in diverse perspectives changes what STEM asks and what it can solve, and alters the methodology of solving STEM-focused problems by making that methodology more inclusive.
Cultural or financial benefit to the university	Increasing diversity provides more representation in faculty and students, which helps with recruitment and allocates more pre-existing resources to diverse populations on campus	Increasing diversity will culturally shift STEM environments at the university and is needed to address systemic hiring inequalities
Direct benefit to students in STEM fields	Increasing diversity provides role models and helps other students by increasing representation and creating spaces within existing systems that are inclusive	Increasing diversity creates a more positive identity for students in STEM fields, and increases their power within the discipline
Societal or economic benefit to families and communities	Increasing diversity fosters success for traditionally underrepresented groups within society's existing structures	Increasing diversity recognizes and challenges the way underrepresented minority communities and familiar and their motivations and attitudes about STEM are perceived

Tremaine and colleagues' investigation considered general reasoning around the importance of increasing diversity in STEM; this is assuredly a different question than asking specific faculty members why *they themselves* work toward enhancing DEI in mathematics.

Investigations into existing faculty motives for engaging in equity work are sparse, and thus determinations about whose interests are centered in equity-oriented reform, on personal and even institutional levels, remain relatively hidden. Given the crucial place of precalculus and calculus to the STEM pipeline (Ellis et al., 2016), the multiplicity of benefits which can result from enhanced diversity in STEM (Tremaine et al., 2022), and the ample calls to address issues of DEI in undergraduate mathematics (Hagman, 2019; Hauk et al., 2021; Larnell, 2023), understanding the motives of undergraduate mathematics community members for participating in equity-oriented work can serve to sustain existing work, and provide a platform for understanding how folks are called into this work such that it can become a shared responsibility. This dissertation aims to "learn more about the reasons current educators have for teaching for equity, and what they think attributed to their development as equity minded individuals (Tuters, 2017; p. 50) through the investigation of individually focused motives for engaging in equity work within undergraduate mathematics contexts. In addition, this work aims to begin theorizing about the link between such motives and their outcomes through the consideration of what mediates the collective development of a shared equity-oriented goal.

2.3: Connecting Individual and Collective Activity

Existent literature provides some indication of a link between individual motives and collective goals through an assertion that the individual and collective dimensions of activities are inextricably linked. Within a CHAT theoretical framing (see Chapter 3), individual motives and collective goals shape each other; when one shifts, the other necessarily is re-mediated and shifts as well (Miettinen, 2005). These shifts are evidenced in the ways in which personal goals can shape disciplinary norms in the sciences (Crandall & Schaller, 2003). Crandall and Schaller discuss how "individual scientists' mundane and very human motives craft the collective values

and practices that define the culture of science" (p. 201). Through the integration of personal perspectives into the processes of research reviewing, analysis, and transmission, they provide an example of how individual goals often supersede abstractly-professed values to create scientific norms that are in contrast to such values. This signifies the importance of individuals' goals in the shaping of a broad and impactful collective context.

In the education context, Saxe (2002) asserts a connection between individual and collective activity in K-12 mathematical development, noting that "individual and collective activities are reciprocally related" (p. 276) and that the relationship between individual and collective goals reflects this reciprocity as children progress in their mathematical learning. Rasmussen and colleagues (2015) bring this into the undergraduate mathematics space by constructing an expanded interpretive framework for linking individual and collective dimensions of undergraduates' mathematical activity, based upon work by Cobb and Yackel (1996), shown in Figure 2. Rasmussen and colleagues' (2015) framework is advanced by their (2024) work, in which they consider a methodological approach to linking collective and individual mathematical activity through detailed conversational analysis and "telling [a] story of the students' collective and individual mathematical progress" (p. 7) with attention to collective mathematical and disciplinary practices, in conjunction with individual meanings and participation. There are two paths toward linking these dimensions: by considering multiple lenses through which to better understand a phenomenon, and by coordinating these lenses to produce a complex portrait of a phenomenon. While the activity of working toward equity within a mathematics department is undoubtedly different from learning mathematics in a classroom setting, the theorizing of these scholars provides a valuable foundation regarding the links

between individual and collective activity. Adapting such work to the context of equity-oriented reform is addressed following my investigations in Chapter 6.

<table>
<tr><th colspan="2">Social Perspective</th><th colspan="2">Individual Perspective</th></tr>
<tr><td colspan="2">Classroom social norms</td><td colspan="2">Beliefs about own role, others' roles, and the general nature of mathematical activity</td></tr>
<tr><td colspan="2">Sociomathematical norms</td><td colspan="2">Mathematical beliefs and values</td></tr>
<tr><td>Disciplinary practices</td><td>Classroom mathematical practices</td><td>Participation in mathematical activity</td><td>Mathematical conceptions</td></tr>
<tr><td>What is the mathematical progress of the classroom community in terms of the disciplinary practices of mathematics?</td><td>What are the normative ways of reasoning that emerge in a particular classroom?</td><td>How do individual students contribute to the mathematical progress that occurs across small group and whole class settings?</td><td>What conceptions do individual students bring to bear in their mathematical work?</td></tr>
</table>

Figure 2. The expanded interpretive framework for connecting individual and collective dimensions of mathematical activity introduced by Rasmussen et al. (2015).

In summary, there is continual need for growth in agency and action toward enhancing equity in introductory undergraduate mathematics (Apkarian et al., 2019; Hagman, 2019; Larnell, 2023). This need for growth is accompanied by an understanding that many individuals in this community are taking responsive stances to this need and working toward equity at their own institutions (Voigt et al., 2023). Scholars have investigated various ideological, experiential, and contextual components which prompt folks in higher education to work toward equity at their institution (e.g. Idahosa & Vincent, 2019; Nadelson et al., 2022), but there exists a dearth in the literature on the ways in which higher education community members motivate their own participation in equity work and how this relates to their collective equity-oriented action. With a basis in literature on activism and professional development in higher education spaces, this

dissertation investigates the motives of undergraduate mathematics programs stakeholders for engaging in a group effort toward equity-oriented reform, and how such individual motives may connect to the collective generation of a goal for that group. This investigation takes place through a CHAT theoretical lens, which is detailed in Chapter 3. CHAT explicitly connects individual motives to collective goals and provides theoretical grounding for the influence of both dimensions on an activity's outcome (Engeström, 1987; 2001; Miettinen, 2005). Prior literature suggests a connection between the individual and collective dimensions of an activity, which motivates this dual consideration (e.g. Crandall & Schaller, 2003; Saxe, 2002; Rasmussen et al., 2015). I aim for this work to contribute to several different knowledge bases, given its interdisciplinary nature, and thus I set forth for this project three scholarly aims for contribution:

- Develop a thematic understanding of what motivates undergraduate mathematics students, faculty, and administrators to undertake collective equity-oriented work.
- Critically analyze a case study of the collective goal generated by a group of students and faculty.
- Provide exploratory coordination of individually expressed motives and collectively generated goals within reform projects.

This begins in the next section, Chapter 3, in which I detail my theoretical and conceptual framework. Then, Chapter 4 (Investigation 1) describes the first investigation, which focuses on five motive themes found in mathematics students, faculty, and administrators' journal entries and interviews. Chapter 5 (Investigation 2) considers a mini-ethnographic case study of collective goal generation to understand what mediates the collective goal generation of a subset of faculty and students from the first investigation. Finally, Chapter 6 provides thoughts on connections between the two investigations to address the final scholarly aim specified above.

CHAPTER 3: METHODOLOGY

In this section, I begin by providing a description of the ACT UP Math project, within which this work takes place. I describe each of the three institutional settings from which participants were recruited, as well as collectively generated positionality statements for those participants. I then detail cultural historical activity theory (CHAT; Engeström, 2001; Roth & Lee, 2017; Núñez, 2021), which acts as an overarching conceptual and theoretical framing for this work. CHAT provides succinct definitions of several concepts key to this investigation, as well as a tool for analysis of equity work in higher education. The methods used for both the first and second investigations are briefly summarized, and will be discussed in depth in the Methods section of Chapters 4 and 5, respectively. This chapter then concludes with my positionality statement, which dissects how my identities and experiences interact with various dimensions of this work (Secules et al., 2021).

3.1: The ACT UP Math Project

I conduct this work in the context of the *Achieving Critical Transformations in Undergraduate Programs in Mathematics* project (ACT UP Math; NSF ECR #2201486), which aims to support critical, transformative, data-driven change toward equity within three mathematics departments. The ACT UP moniker is borrowed with permission from community leaders involved in the ACT UP activism group with the intention of mirroring their commitment to transformative change in action. The institutions involved in ACT UP Math will be referred to by the pseudonyms Alpha University (AU), Kappa University (KU) and Tau University (TU). Each university is described in more detail later in this section. We selected these universities due to their prior involvement in large, NSF funded projects (*SEMINAL* (NSF DUE #1624610)

and *Progress through Calculus* (NSF DUE #1430540)) focused on understanding student experiences in introductory mathematics and implementing active learning practices in introductory undergraduate mathematics courses. Through involvement in these projects, each NIC has access to extensive data from their institution about students' experiences in conjunction with demographic information, including students' responses to the student postsecondary instructional survey in mathematics (SPIPS-M; Craeger et al., 2022), which links a variety of social identities to classroom experiences and student perceptions.

The ACT UP Math project is structured as an equity-oriented research-practice partnership (Farrell et al., 2021) encompassing varying layers of Networked Improvement Communities (NICs; Martin et al., 2020). NICs collectively cultivate understandings of pertinent issues and problems, consider and implement actionable responses to those issues or problems, and consider measurable outcomes (Martin et al., 2020). Each participating institution has its own local NIC, consisting of administrators, mathematics faculty members, and mathematics students at that institution. The NICs are led by faculty members and/or administrators, several of whom have previous experience working on large NSF-funded projects. Each local NIC has a dedicated local research team, which is a subset of the entire ACT UP Math research team. Together, the research team and local NICs make up the entire ACT UP Math project NIC. This structure is illustrated by Figure 3 below.

Particularly relevant to this study is the notion that NICs are expected to collectively generate "a clearly defined and measurable outcome that the network commits to accomplishing" (Martin et al., 2020, p. 2). Thus, unlike other professional development or departmental change efforts, AU, KU, and TU's NICs did not begin with a clearly defined goal, but rather was expected to develop one through engagement with and analysis of local quantitative and

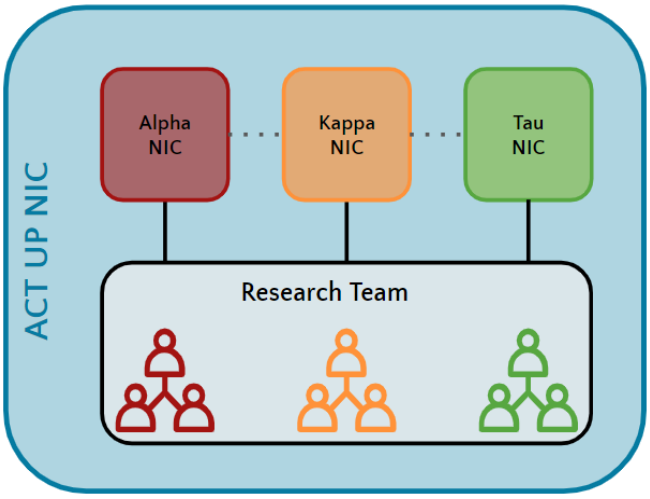


Figure 3. The structure of the ACT UP Math NIC, adapted from Hagman et al. (2024).

qualitative data. For the local NICs, this meant that objectives were not specified by the research team, allowing for an open-ended goal generation process to which they bring their lived personal and professional experiences to contextualize institutional data (Dowd, 2005). The lack of a clearly defined objective for the NICs apart from an expectation for critical, transformative, and data-driven change provides a foundational setting for this work, in which individuals' motives are investigated, and then the conversational coalescing around a local NIC objective is discussed.

Below, I provide institutional details about AU, KU, and TU, including undergraduate enrollment demographics. These descriptions are followed by a positionality statement for each of the local NICs, composed by a research team member following an activity in which we asked NIC members to share identities which felt salient to their equity-oriented work. Upon writing, participants were invited to edit or affirm the positionality statements associated with their institution, resulting in the final co-constructed statements which represent identities salient to NIC members as of the Spring 2024 semester. Importantly, all three NICs have both undergone membership changes since the ACT UP Math project began in Spring 2023. Because these

positionality statements were drafted in early Spring 2024, they are not fully reflective of the identities present in my sample, but the overlap in membership between the time(s) of data collection for this work (Spring and Fall 2023) and the writing of the NICs' positionality statements (Spring 2024) is significant enough to still include these statements as indicative of identities that felt salient to NIC members throughout this work. We use collective statements, rather than summaries of individual identity markers, out of respect for an agreement reached with NIC members in which their pseudonyms would not be individually linked to their social identities.

Alpha University (AU) is a public, Master's-degree-granting institution with moderate research activity (R2) in the western United States. Institutionally documented data indicates that AU's undergraduate population is 37% Hispanic and/or Latin*, 25% Asian, 16% white, 11% Black or African American, and 5% multi-racial. Approximately 60% of undergraduate students identify as women, 40% as men, with <1% identifying as non-binary. A majority of AU undergraduate students are first-generation college students. AU had previously participated in the *SEMINAL* project (NSF DUE #1624610), which enhanced their capacity for incorporating active learning into their introductory mathematics coursework. At AU, introductory mathematics courses are taught primarily by faculty members in small classes using active learning strategies. The AU NIC is led by one faculty member, Caroline, and one administrator, Angela, who recruited NIC members from the entire mathematics department and intentionally sought to include student members from the beginning of the project. Data used in this project is from the Spring 2023 semester, during which their NIC included three faculty members, one administrator, and four student members.

As of Spring 2024, most NIC members identify themselves as math lovers, and many identify as role models with orientations towards helping, teaching, or tutoring introductory math courses. NIC members hold varied racial and ethnic identities including Latinx, Chicana, white, Filipino, and mixed race. NIC members also shared that their identities as Queer, Disabled, First-Gen college students, and/or survivors of trauma feel relevant as they work to change and "reimagine" math spaces.

Kappa University (KU) is a private, not-for-profit, highly selective doctoral-degree-granting institution that is research-intensive (R1) in the southern United States. Introductory mathematics courses are taught in large lecture settings by faculty members, who are supported by undergraduate or graduate Learning Assistants. According to institutionally documented demographics, KU's undergraduate students are 48% white, 21% Asian, 10% Black or African American, 8% Hispanic and/or Latin*, and 3% multi-racial. Without an institutionalized option for non-binary genders, 50.5% of the undergraduate students identify as women, and 49.5% identify as men. KU previously participated in the *Progress through Calculus* project (*PtC;* NSF DUE #1430540) which provided them with substantial local data about student experiences in introductory mathematics, disaggregated by demographic markers. Their NIC is led by two faculty members, Skylar and Tiersa, who recruited NIC members through open-ended email surveys of interest and personalized invitations.

Initially, the KU NIC consisted of three administrators and four faculty members, all of whom were at least tangentially involved with calculus 1 and 2 at KU, and all of whom identified as women. Learning from AU's success in incorporating students into their NIC membership, KU chose to include undergraduate and graduate student members for the Fall 2023 semester. Data from both iterations of NIC membership are included in this analysis (Spring 2023 KU NIC

and Fall 2023 KU NIC, between which there are four overlapping members). As of Spring 2024, the KU NIC's membership is reflective of its Fall 2023 membership. This NIC consists of two undergraduate students (one of whom is an international student), two graduate students, and four faculty members, some of whom are in their early career. The graduate students and the faculty members are all actively involved in undergraduate mathematics instruction at KU. Most members of the NIC identify as "math people," but several recognize that they have experienced struggle throughout their mathematical journeys. All but one are math majors or hold degrees in mathematics. In addition to these practice-based identities, many members recognize explicitly that they hold "characteristics that the dominant educational system is designed to privilege, and have benefitted from these." A majority of the NIC identify as white, as women, and as United States citizens, and about half as young adults. The NIC also includes individuals who identify as transgender, as Queer, as a first generation American, or as part of a working class background.

Tau University (TU) is a public doctoral-degree-granting university with moderate research activity (R2) in the southern United States. Institutional demographics indicate that TU's student body is 54% white, 22% Black or African American, 11% Hispanic or Latin*, 5% Asian, and 4% multi-racial. Along a gender binary, 50.8% of TU students identify as men, and 49.2% identify as women. Most introductory math courses are taught by faculty in small classes, with some instructors using active learning strategies. Like AU, TU had previously participated in the SEMINAL project to support active learning practics. The NIC is led by three individuals, Olivia, Garrett, and Natalie, two of whom are mathematics faculty members and one of whom is a university-level administrator. They recruited NIC members through a widely shared invitation, including emails and publicization at a department meeting. This project uses data

from Spring 2023, during which the NIC included one administrator and ten mathematics faculty members.

In Spring 2024 the NIC introduced three new members, one did not continue. One of the new members is an undergraduate research assistant from biology. This positionality statement reflects the responses of participants from Spring 2024. About half of the NIC members identify as women. The NIC also includes individuals who identify as persons of African descent, first-generation, and non-native English-speaking. Additionally, NIC members shared identities that likely influenced their experiences as educators: parents, single, and Gen-X (with over half identifying as middle-aged). Several members also indicated that imposter syndrome, struggling with procrastination, and significant personal stresses all influence their engagement with the NIC.

This section is intended to provide context for this work, with the recognition that the motives I study–both individual and collective–are specifically relevant to participation in the ACT UP Math project. This means that motives are likely influenced by attributes of the project. For example, the NIC structure may enable more motives which are focused on collaborative components of reform. Additionally, institutional context is important to note. Of particular relevance to this work is that both KU and TU are located in states in which DEI work within higher education is under legislative attack (Chronicle of Higher Education, 2024). While they likely experience such a political climate differently, this is an additional dimension of context that could be salient to what motivates individuals to partake in equity-oriented work, as well as how they come together to develop a shared objective for their NIC's work. The next section further elaborates on how contextual factors can impact motivation by discussing the conceptual and theoretical framing for this work: cultural historical activity theory.

3.2: Cultural Historical Activity Theory

This work finds theoretical and conceptual grounding in cultural historical activity theory (CHAT; Engeström, 1987). Grounded in the work of Vygotsky (Vygotsky & Cole, 1978), Leontiev (1978; in Com-Deng, 2022), and Engeström (1987; 2001; 2015), CHAT provides a succinct framing for considering how motives interact with other components of activities, while still recognizing the complexity inherent to analyses on the construct of motive. In this section, I first provide a brief history of CHAT, define the myriad of interconnected concepts which it outlines, and discuss its relevance to the two investigations conducted for this dissertation.

3.2.1: Development

CHAT has undergone three iterations in the past century (see Figure 4 for a summary). These iterations are commonly referred to as *generations,* with a fourth generation presently in development. The first generation of CHAT is credited to Lev Vygotsky (Vygotsky & Cole, 1978), who, rooted in Marxist traditions, contributed two major principles to the development of CHAT: *mediation* and *socioculturalism* within learning and development. With regard to the former, Vygostky conceptualized behavior as a triad between a stimulus, a response, and a mediating material or conceptual tool, which then expanded an individual's zone of proximal development, resulting in learning. In the CHAT context, Vygotsky's mediated stimulus-response triad is commonly reformulated to represent an individual subject orienting toward a particular object, mediated by material or conceptual artifacts (Engeström, 2001). As an example of this triad, I consider my own participation in the activity of working toward a PhD. The *subject* is myself and the *object* is the attainment of the PhD, but my journey toward realizing the object is mediated by physical, social, and cultural artifacts of my PhD program, such as standards which qualify my performance on exams, or the affirming social relationships I build

while in the program. The notion of socioculturalism created theoretical grounding that learning was inexplicably intertwined with social and cultural environments–hence, learning within CHAT is a sociocultural activity (Roth & Lee, 2007). While there exists scholarly debate around whether Vygotsky actually considered mediation and socioculturalism as components of *activity* explicitly (Cong-Lem, 2022), there is little doubt that these two notions formed the foundation upon which future generations of CHAT were constructed.

In fact, it was Vygotsky's own student, A. N. Leontiev (1978, in Com-Deng, 2022), who propelled CHAT into what is considered its second generation. Leontiev expanded Vygotsky's (1978) triad to consider the *collective* nature of activity in 1981 (Engeström, 2001). While Vygotsky's first generation model maintained an individual focus–that is, activity is conceptualized as something done by an individual, although mediated by broader societal and cultural artifacts–Leontiev's notions of activity considers activity to be an explanatory construct, which fundamentally transforms the object, the subject, and how they are mediated (Cong-Lem, 2022). Maintaining Vygotsky's focus on socioculturalism, Leontiev also expanded the notion of *what* could mediate activity through a more explicit consideration of norms and community in which any given activity is contextualized.

Yrjö Engeström's (1987) interpretation of Leontiev's work further refined second-generation CHAT through the construction of a clearly defined and articulated set of concepts which mediate activity. In order to do so, Engeström considered activity as something done collectively with a shared object, therefore lending activity greater concreteness; instead of activity as an amorphous and constantly changing complex system, activity is simplified to something closer to the Western colloquial definition, in which ways of collectively orienting toward a shared object, such as participating in professional development, are considered activity

(Cong-Lem, 2022). Alongside Vygotsky's original (CHAT-interpreted) notion of mediating tools and signs shaping the relationships of a subject to an object, Engeström further included rules, community, and divisions of labor as interacting within an activity, and mapped these out to expand Vygotsky's original triad, creating a triangular model with connections between the additional constructs (Figure 4). Engeström's model further asserted the importance of the object to the outcome of an activity within this diagram. Based on Engeström's background in adult education (Cong-Lem, 2022), Engeström's construction is widely used in contemporary CHAT-based education studies, though it is not without critique. Engeström's naming of discrete constructs in second generation CHAT allows for a certain conceptual rigidity that reduces one's ability to study the inherent complexity of activity (Toomela, 2008 in Cong-Lem, 2022). However, second generation CHAT remains a useful model through which to think about *activity in practice*, such as social justice activities or discrete change efforts due to its conceptual clarity (Sumbera, 2021).

The third generation of CHAT is credited to the work of Engeström (2001), and involves the consideration of at least two interacting activities within an activity system. Each of these activities may have their own (though perhaps congruent) subjects, mediating artifacts, rules, communities, and divisions of labor, resulting in objects which can be both distinct and cooperative. These objects interact in meaningful ways to produce tensions or contradictions as the activity system moves toward an outcome (Engeström, 2001). Third generation CHAT enables consideration of larger, complex systems in which there are many groups of actors partaking in diverse activities within the same environment with some partial overlap in objective, such as systems of higher education (Núñez, 2021). Engeström (2001) refers to this as the *multi-voicedness* of activity systems, and notes the possibility for the study of activity

systems to result in more expansive transformations within these complex contexts. Figure 4 provides a summary of the first three generations of CHAT, including what acts as the unit of focus for each theory, and credited authors for each generation.

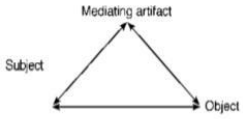
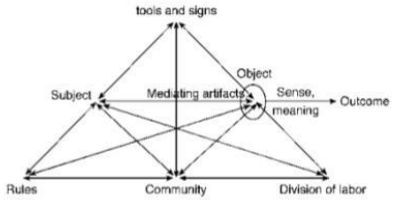
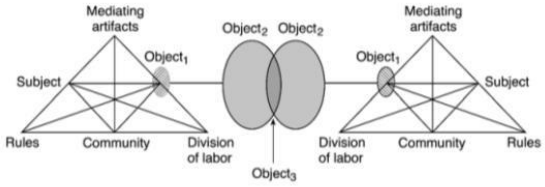
Generation	Unit of Focus	Credited Author(s)	Visual Representation (Engeström, 2001)
First Generation CHAT	An Individual who engages in the mediated pursuit of an object	Vygotsky (1978)	
Second Generation CHAT	An Activity performed by a group of individuals, or group of groups, collectively oriented toward a shared mediated object	Leontiev (1987) & Engeström (1987)	
Third Generation CHAT	An Activity System in which two or more activities, each with their own mediated objects, interact	Engeström (2001)	

Figure 4. The first three generations of CHAT.

A fourth generation of CHAT is presently in development, credited principally to Annalisa Sannino and Yrjö Engeström, and focuses on expanding CHAT to include a greater number of interconnected activities alongside global contextual elements of activity systems (Yamazumi, 2020). Motivated by a need to address sizable challenges facing our global community, such as poverty and climate change, propositions relevant to the development of fourth generation CHAT includes explicit attention to collective transformative agency, the relationship between learning and global challenges, and the longer-term consequences of activity, all while maintaining CHAT's foundational commitment to socially constructed cultural and historical contexts. In this way, it aims to go beyond well-defined activity systems, as might be studied by third generation CHAT, to consider systems in which "not only [are there]

different types of activities but they are also at different levels–national governmental organizations as well as local, regional, and even very specific families and villages" (Engeström, in Yamazumi, 2020, p. 3). These initial considerations form the foundation for Sannino and Engeström's work, which is ongoing and may result in a clearly defined fourth generation CHAT in the coming years.

3.2.2: CHAT in Context

In order to center this study on the motives present within and goals of local NICs participating in ACT UP Math, I leverage the second generation of CHAT (Engeström, 1987). Affordances of this particular generation for the present study include a clearly defined set of constructs, and the ability to conceptualize a local NIC as an *activity in practice.* Further, because I intend for the first study to zoom in on a particular dimension of subjects–their individually expressed motivations for activity participation–a third generation CHAT framework would prove too expansive to meaningfully investigate any relationship between individually expressed motives and the collective goal generation process of a local (AU, KU, or TU) NIC. Notably, a study through a second generation CHAT lens does not inhibit, but rather contributes to, future opportunities to consider the activity of a local NIC through a third-generation CHAT lens. As Núñez (2021) notes, nested analyses using CHAT can prove useful for understanding more localized versus broader contexts, resulting in a greater breadth of knowledge that can then be used in planning changes to improve the effectiveness of an activity system. Figure 5 showcases the traditional triangular structure given to second-generation CHAT. This triangular representation has received critique for continually reifying the notion of each dimension as a separate, discrete component of an activity system, without an ability to account for change within these components over time (Langemeyer & Roth, 2006). Despite these critiques, the

triangular representation continues to be a useful visual tool and is a widely-used model for analysis.

Leveraging CHAT as a theoretical and conceptual framing necessitates conceptualizing the local NIC as an *object-oriented activity.* Yagamata-Lynch (2010) defines an object-oriented activity as the "mediational processes in which individuals and groups of individuals participate driven by their goals and motives, which may lead them to create or gain new artifacts or tools intended to make the activity robust" (p. 17). Thus, shared goals and motives (or *objects*, as CHAT scholars refer to them) are considered central to the ongoing evolution of an activity. Within the local NIC, individuals are participating in an effort to enhance equity at their institution, and this necessarily involves continual mediational processes, including exploring and understanding local data, considering department or institution-wide policies that may interfere with or support their work, or acting democratically within the NIC to ensure the input of all members. All of these processes then mediate the development of the NIC's overall object. An object-oriented activity is inherently complex; Roth and Lee (2007) describe it as an "evolving, complex structure of mediated and collective human agency" (p. 198). Thus, the local NIC is not taken to be any discrete action of one individual, but rather a system in which a group of subjects undertake mediated, object-oriented behavior.

Here I provide greater detail on what is meant by each of the concepts presented in second generation CHAT, as showcased in Figure 5, and discuss how these relate to the activity of the NICs.

- The *subject(s)* within an activity are the groups or individuals performing the activity– Lee (2011) refers to them as the agents of the activity. Within the local NIC, the subjects are the student, faculty, and administrator members of the NICs.

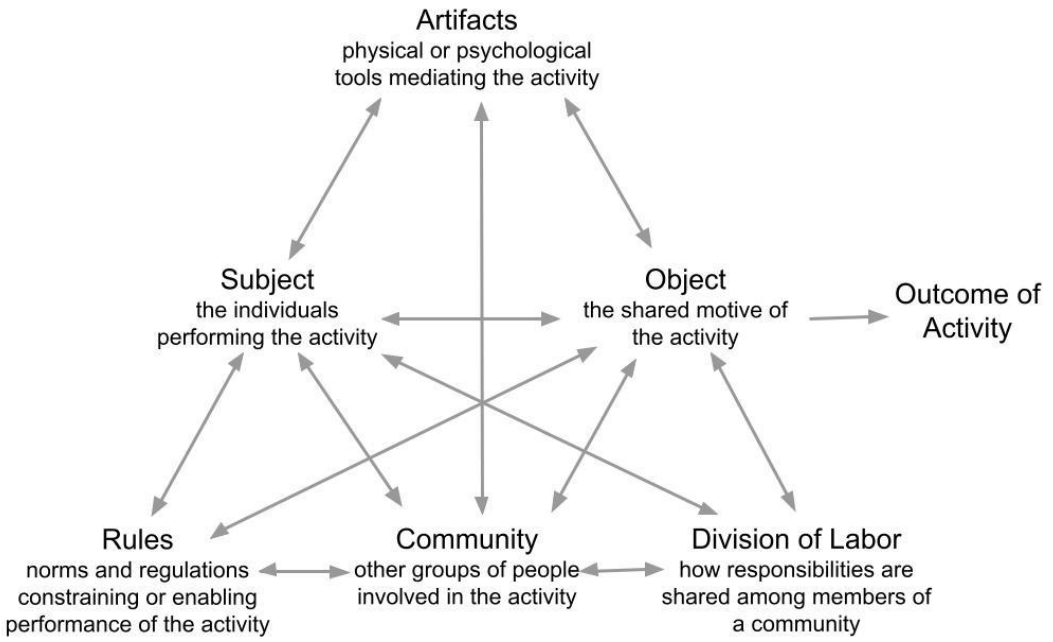


Figure 5. A model of second generation CHAT, adapted from Engeström (1987) and featuring brief descriptions from Cong-Lem (2022).

The subject dimension also encompasses what attributes of the subjects themselves that impact their personal participation in the activity, including individual motives, identities, and emotions (Miettinen, 2005).

- The *artifacts* of an activity consist of "culturally developed physical or symbolic tool[s] – like prior knowledge, concepts, or language" (Núñez, 2021, p. 12). Similar to Vygotsky's original notion of mediating tools, artifacts can be both material (i.e. the arrangement of desks in a classroom) and psychological (i.e. a critical theory) (Cong-Lem, 2022). Artifacts can also include ideologies which act as mediating factors within an activity. For example, Sumbera (2021) includes systemic oppression, critical consciousness, and theories of social justice as artifacts in their analysis of the development of equity-oriented educational leaders.

- An activity's *rules* are the norms and regulations which guide practices within the activity. Rules can be either informal or formal, and either explicitly established or implicitly practiced, and they can vary in the extent to which they act as influencing factors for the practice of the activity (Núñez, 2021).
- *Community* refers to the groups of people who surround the activity, including groups outside of the subjects who may be impacted by the activity or who can influence its direction. For the NICs, this may include their mathematics department, students, their institution, or society more broadly.
- *Divisions of Labor* refer to the ways in which activity tasks are distributed among subjects in the activity, and can be both internal to the activity itself, or external with regard to what community groups may expect from subjects (Núñez, 2021, Roth & Lee, 2007). Divisions of labor within and outside of a NIC may include expectations placed upon the NIC from their outside communities, or internal distribution of who within the NIC is responsible for what. An example of this is the formal instantiation of NIC leaders within a NIC, who are responsible for determining structure for NIC meetings and often guide conversation. For these investigations in particular, I also include internal power dynamics as relevant to the construct of divisions of labor, because such power dynamics serve to determine who has authority to speak on which topics within the KU NIC.
- Finally, I highlight the *object* of an activity. As indicated in the definition of an object-oriented activity, the object is the "motive, goal, or product" toward which the activity works (Sumbera, 2021, p. 24). In this way, CHAT does not view a distinction between articulated reasoning for performing an activity and a

developed goal; they are one in the same as they both provide foundational guidance for the activity. Núñez (2021) considers an object to be any goal(s) or desire(s) which "guide the reason for doing the activity, and the organization of the activity itself" (p. 12). Dowd and Liera (2018) use the phrase "motive and collective sense of purpose" (p. 9) to describe an object within CHAT, emphasizing its shared nature within the activity's context. Scholars also point to the fluid nature of an activity's object; Lee (2011) describes the object of an activity as "that which is to be changed" (p. 407). Many scholars argue that an activity's object *necessarily* shifts through activity participation. Nishio et al. (2020) note that objects are transformative and inherently unstable; they temporally shift through engagement in the activity.

As a member of the family of sociocultural theories, CHAT necessarily considers with all of these elements various dimensions of culture that could impact them. Roth and Lee (2007) contend that research leveraging CHAT considers expansively the cultural and historical components that influence elements of any given activity. An attention to the cultural and historical context in considering what mediates the transformation of an object within an activity enables CHAT to tackle several pervasive issues in educational change research: it considers an expansive context, embraces the complexity of educational activities, and incorporating issues of power and politics, as well as emotions and identity (Lee, 2011). Núñez (2021) provides a powerful argument for CHAT's relevance to equity work within the higher education context specifically. Because CHAT considers activity as a unit of analysis, it enables a more holistic consideration of systems and structures which transcends other theories which consider individuals' perspectives or actions as a unit of analysis. Given the complexity of systems within

higher education–the multiplicity of actors, the connections to broader communities, diverse levels and enforcements of implicit and explicit rules, and the ways in which divisions of labor manifest–a CHAT lens enables attention to these complexities while still weaving a cohesive storyline around the tensions and contradictions that arise within such complex systems.

The current study's focus is on one dimension of the complex system of conducting collective equity work within undergraduate mathematics departments: the motives with which the work is performed. I study these motives as individual and collective foci for investigation through a CHAT lens. The first is an individual dimension, in which I investigate the individually expressed motives of mathematics faculty, administrators, and students across three institutions for participating in the local NIC through a reflexive thematic analysis (Braun et al., 2023) on journal entry and interview data. Understanding these motive themes through a CHAT lens places them squarely in the service of better understanding the *subjects* who partake in the activity of a local NIC, and as such they are positioned as having the power, mediated by other factors, to shape and re-shape the object of the activity of the local NIC as a collective, and therefore the outcome of the NIC's work (Miettenin, 2005). The relationship between the object(s) of an activity system and its subjects is established in previous literature as significant to the activity itself; Roth and Lee (2007) write that object and subject change mutually within the performance an activity, writing explicitly that "what the relevant object is in actions and activities observed depends on who the acting subject is" (p. 198), implying that subjects themselves (and their associated attributes, such as individually held motives) deeply shape the objects developed and refined throughout the activity. I refer to these individual motives as *motives*, although I define them in a way derived from CHAT's definition of an *object* for methodological consistency. Thus, the investigation of motives leveraged in the first

investigation relies on an understanding of motive as that which guides the individual's decision to partake in the activity of the local NIC, to include both reasoning and goals for participation. The outcomes of this investigation paint a clearer picture of this internal dimension of the subject within the broader activity of the local NIC.

The collectively generated *object* of the local NIC is the focus of the second investigation. Through a mini-ethnographic case study (Fusch et al., 2017) I work toward an understanding of how one local NIC (Kappa University) constructed a shared object for the activity of their local NIC. While one NIC meeting in which they construct an object acts as the central data for this analysis, it is contextualized with data of various forms, including field notes, journal entries, and interviews, to produce conclusions about what shaped KU's development of their object during the meeting. While object and motive are synonyms under a CHAT theoretical lens, I will continually refer to the collectively generated object of the local NIC as an *object* to avoid confusion with the individual *motives* that participants express for joining the NIC.

An analysis of the development of the NIC's object necessitated understanding the audiovisual data of the meeting in question through a CHAT lens, and therefore determining the artifacts, components of subject, implicit and explicit rules, communities, and divisions of labor involved in the development of the object to understand what proved foundational to the local NIC's collectively generated object. Lee (2011) affirms the validity of such an approach:

> Although any one or more of the mediators in an activity system can be foregrounded, the rest are not absent and are in fact indispensable to describe the 'hows' and 'whys' of subjects' transformation of objects. (p. 407)

As such, to consider how the NIC came to a collective, shared object for their NIC work, the other dimensions of CHAT are necessarily considered. Roth and Lee (2007) provide an analogy of interweaving fibers to form strands as the elements of CHAT. They note that "a unit can be analyzed in terms of component parts, but none of these parts can be understood or theorized apart from the other that contribute to defining it" (p. 196). Objects are one such fiber within the strand of an activity system; while we can look at this particular object fiber, it is deeply and necessarily interrelated to the other fibers with which it is interwoven and the overall activity itself. Specific to this project, the object developed collectively by a local NIC does not stand alone but is influenced by other dimensions of local NIC activity.

By studying the development of an object within the activity of the NIC, I remain true to CHAT's initial Vygotskyian ideals by studying a process of learning as defined with the CHAT system. Roth and Lee (2007) define learning in the following way, drawing from the work of other scholars to support their definition:

> Learning occurs whenever a novel practice, artifact, tool, or division of labor of the individual or group within an activity system constitutes a new possibility for others (as resource, a form of action to be emulated) leading to an increase in generalized action possibilities and therefore to collective (organizational, societal, cultural) learning. (p. 205)

In a sense, the subjects of a local NIC are learning as they construct a collective object, in that they leverage different dimensions of an activity system to expand (and refine) their action possibilities. The conversation in which the expansion and refinement of an object took place then becomes a suitable point of analysis within a CHAT framing.

In both investigations, I am leveraging CHAT as a theoretical and conceptual grounding, and *not* as an analytical method. An oft-cited strength of CHAT is its ability to act as both a theory and a tool for praxis (Lee, 2011; Núñez, 2021). While consideration of the methodological affordances of a CHAT analysis provides a foundation for future work based upon the studies in this dissertation, I emphasize that neither of the investigations in this work are traditional CHAT *analyses*, but are analyses of different methodologies (reflexive thematic analysis and mini-ethnographic case study methodologies, respectively) which have theoretical grounding in CHAT. The decision to forgo a traditional CHAT analysis was made for two principle reasons, detailed below.

The first reason is that CHAT analyses are designed to center contradictions and tensions within activities as sources for development (Engeström, 2001; Roth & Lee, 2007). These are often referred to as *disturbances* within an activity, and the re-mediation of processes within the activity to mend such disturbances between CHAT components is crucial to the narrative produced by a CHAT analysis (Núñez, 2021). The foci of interest in this work is a time-bounded *development* of a collective object within an activity prior to any arising disturbance. Using development instead of disturbance as entry point for a CHAT-based investigation veers away from traditional CHAT analyses, which consider explicit emphasis on actionable response to contradictions and tensions which arise in such work (Roth & Lee, 2007). Without a contradiction on which to predicate the development of the object by the local NIC, this analysis cannot be a CHAT analysis.

The second reason for the use of CHAT as a theoretical and conceptual framing without the use of a CHAT analysis is the time-bound nature of this analysis. I have chosen to consider as central the second investigation a discrete unit of data (one local NIC meeting in which an

object for NIC activity was developed). While my analysis of this unit of data will be contextualized using other forms of data as informants of the broader history and culture of the ACT UP Math NIC, as would necessarily be the case within mini-ethnographic methodology, this kind of centering of a discrete event is not practiced within a CHAT analysis unless that discrete event constitutes a contradiction or disturbance within the activity. Once more I highlight that the focus of the investigation is on development and not disturbance, and consequently a CHAT analysis on this discrete, non-disturbance event would be inappropriate. While there is precedent for conducting a CHAT analysis on an activity *without* a previously identified disturbance event, these analyses are overarching analyses constituting years of data collection to create a holistically descriptive CHAT understanding of the activity in its entirety (see, for example, Sumbera, 2021). Because my intention is to focus on the particularities of the motives and object(s) within the activity of the local NIC, and not construct a holistic understanding of local NIC activity itself, a CHAT analysis once more proves inappropriate.

As such, I provide Figure 6 as a visual depiction of how CHAT is leveraged as theoretical and conceptual grounding in the two investigations of this current study. Particularly because the investigation of the development of a collective object in the second investigation could be conflated with a CHAT analysis due to the similar structure leveraging Engeström's (1987) triangular model, I adapt the model to foreground directional arrows connecting each of the other CHAT concepts to the object of activity. While connections between the other objects are still necessarily present and are still discussed in analysis, they are de-emphasized in favor of enhancing understanding of how the collective object is generated with relevance to the subjects, artifacts, rules, communities, and divisions of labor within the activity of the local NIC. They become relevant only insofar as they serve to construct a path among the different elements

toward the development of the object. Further, arrows indicated influence *from* the object *toward* other components of the activity are eliminated to emphasis that, in the second investigation on the collectively generated object, that object is held constant as the outcome of the generative conversation.

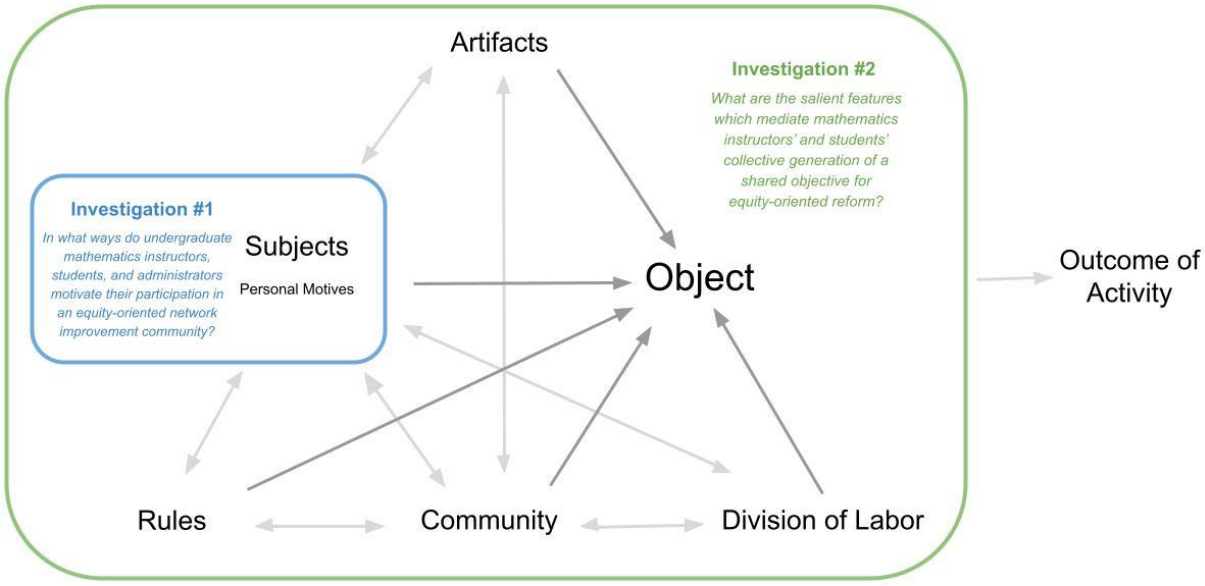


Figure 6. A visual depiction adapting Engeström's (1987) triangle model to describe the present analysis, which focuses on both individually expressed motives and the development of a collective object.

3.3: Positionality

Prior to introducing the methods, findings, and discussions for the two investigations I undertook within this dissertation, I must position myself within this work. In line with many scholars across the last century, I reject the idea of research as objective or values-free, and instead consider this work (along with all other scholarly work I produce), to be "a complex intercultural mediation and a dynamic interpersonal experience" (Ryder, 2021, p. 312). The dynamic nature of this experience necessitates operationalizing positionality as reflexivity through critical self-examination and ownership of the ways in which my identities, experiences, and ideologies interact with my scholarly work. In addition to supporting my own development

as an equity-oriented practitioner in higher education (Idahosa & Vincent, 2019), this reflexivity enables me to communicate ways in which this research is *not* neutral, and was undertaken intentionally with an awareness of my own influence on the process. In order to critically reflect and clearly communicate my positionality, I structured my reflection around Secules and Groen-McCall's (2019) six dimensions of positionality: research topics and questions, epistemology, ontology, methodology, researcher-as-instrument, and communication. I wrote the following section by synthesizing my individually journalled reflections to prompts provided by Secules and colleagues (2021) designed for critical consideration of each of these six dimensions, and present that synthesis in this section.

The vast majority of my scholarly contributions during my time as a graduate student have centered around issues of equity, diversity, and inclusion, often leveraging critical theories or critical methodologies to explore topics related to stakeholders' perspectives on equity issues in undergraduate mathematics education (see, for example, Tremaine et al., 2022; Tremaine, 2021; Tremaine et al., 2023). I am informed in this work by my own multifaceted identity that encompasses privileges associated with whiteness, heterosexuality, and income security. Traditional markers of academic success (grades, graduation, progress within a graduate program, positioning as an instructor) label me as someone with power in mathematical spaces, and the valuation of mathematical success as an implicit marker of intelligence (Gutiérrez, 2017; Roth et al., 2015) privileges me within academia and within US society more broadly. Simultaneously, I navigate the masculine space of mathematics as an expressively feminine individual and as someone whose research is cross-disciplinary and socially scientific, both of which have led to personal experiences of gendered and disciplinary marginalization in courses and in social settings (see Ohsiek, 2022 for a dissection of such marginalization from another's

experiences). As my power within academic spaces has increased during the course of my graduate studies through positions of organizational leadership and opportunities to mentor others, I have grown particularly aware of my own place in Larnell's (2023) call to move beyond equity work as the work of a "small, impassioned group fo reformers" toward a responsibility "shared by the entire community" involved in undergraduate mathematics educational leadership. I recognize both my personal responsibility to take up this call in my research, instruction, mentorship, and advocacy, but also my ability to responsibly call others into this work. A first step to understanding how to call others into spaces of equity-oriented changes in our mathematics programs is to understand why those presently doing such work have chosen to be there, to take an actionable stance, and begin to theorize how such reasoning might impact the outcomes of that work.

My choice to focus on individual motives and collective object generation is further informed by my experiences as an exercise physiologist. Prior to pursuing my mathematics degrees, I earned a degree in kinesiology and worked for several years constructing and overseeing exercise routines. In the fitness industry, motives are a frequent topic of conversation, and strong links between motives for fitness and the actions individuals choose (or do not choose) to undertake are assumed. When considering this in the context of equity work in undergraduate mathematics education, I found this link undertheorized. This dissertation is an attempt to begin creating an understanding of the link between motives and action in educational equity work through an investigation into individual's motives and an assessment of how a group of individuals then goes about constructing a shared object to guide their activity. What this brings into my work is an assumption that there *is* such a link; that investigating motives and collectively generated objects has value because of the potential of the two to inform activity. I

intentionally chose a theoretical framework, CHAT (Engeström, 1987; 2001), which shares this assumption, although even CHAT is critiqued for not clearly outlining mechanisms through which its constructs relate to the outcome of an activity. While drawing empirical conclusions about this link between motives and *outcomes* is outside the scope of this study, I aim to provide preliminary results that could inform the development of such a link through considering potential links between individual motives and collectively generated objects which guide an equity-oriented activity.

In considering my own motives–an exercise began in the introduction of this dissertation–a motive of self-interest is evident. The ways in which I hope to advance the scholarly underpinnings of equity reform through an investigation of the motives for such work converge with my own personal desires to successfully navigate the academic doctoral system and obtain a PhD, which affords me additional economic privilege. Upon graduation, I aim to become an assistant professor–specifically, a white assistant professor–in a discipline which historically and contemporarily upholds the hegemony of whiteness. These self-oriented components of my own motives for engaging in these investigations position me well to uphold the very dominant narratives which I aim to critique in mathematics equity reform. I am fortunate to be surrounded by supportive communities of mentors and peers who continually push my work toward criticality and challenge me to investigate my own lens; that has been true of this dissertation work, and true of other equity-oriented work I engage in, in both scholarship and teaching communities.

I also share that I am motivated to engage in this work because I believe strongly in the need for greater equity in undergraduate mathematics education. It is impossible for me to separate my reasonings for this need from the framework we developed in Tremaine et al.

(2022); I believe that many levels of entities benefit from enhancing equity (industry, institutions, students, families and communities), and believe that there are benefits to be had from both enhancing access and achievement to a broader range of individuals within existing systems, and also that there exists an imperative to rethink educational systems which oppress and exclude, radically re-envisioning what those systems could look like if oriented to serve the interests of those who have historically been excluded.

Understanding the epistemological and ontological perspectives I bring into this work necessitates explaining how my positionality impacts how I know what I know, and how my positionality impacts what I can observe as a researcher (Secules et al., 2021). For this study in particular, I leverage critical realism (Egbo, 2005) as an ontological and epistemological stance that informs this work. Critical realism rejects the idea that objectivity can be reached, instead asserting that "good research means we can understand the world better" without the need to uncover an objective truth (Vincent & O'Mahoney, 2016, p. 1). A direct consequence of this is that participants' own perceptions of their experiences are "valid social scientific data that can lead to consequential social transformation" (Egbo, 2005, p. 271). This informs the way in which I study individual motives; that particular investigation considers participants' own perspectives of their motives in the analysis (that is, their response to being directly asked to describe their reasoning for joining the NIC), in addition to motives which are expressed in the context of other journal or interview prompts. Participants' perspectives on their own motives (much as I elaborated on my own motives) are treated as valid indicators of their true motives as they are true to the participants' own experiences and understandings of their participation in the NIC.

An additional dimension of the first investigation related to this ontological and epistemological stance is the member-checking process, in which I sought feedback from

participants about the resonance of the five motive themes I developed from their journal and interview responses. This practice is particularly important given the solitary nature of my own lens in this analysis; while I have worked with my advisor to process the findings from each investigation and drawn upon the expertise of my dissertation committee at various points in this research, the individualistic nature of the dissertation process has meant that my efforts to understand both participants' individual motives and the KU NIC's collective goal generation process are filtered through almost exclusively my own lens. Without a more robust process for interrater reliability or code validity as can exist in more collaborative research, it becomes particularly important that I am verifying my findings with participants themselves. Asking them to reflect on the resonance of the themes I developed as a part of the first investigation was one way of interrogating the validity of my codes within my current positioning as a doctoral candidate working on a supported but largely solitary dissertation project.

Notably, under a critical realism paradigm, multiplicity of reality can be maintained; my perceptions of participants' motives and their own perceptions of their motives can both be true, even if they are in conflict. However, I have only an outsider perspective on their realities. In Investigation 1, I am limited in my exploration of individual motives to what participants are comfortable and capable of expressing in their journal entries and individual interviews. Participants could hold motives which exist outside of what they feel comfortable expressing to myself or other ACT UP Math research team members. There may be motives which exist beyond verbal or written expressibility. What I am able to access in these forms, I am limited to interpret through my own worldview. A participant saying that they are motivated to join the NIC because their "primary professional interest is making math a welcoming and inclusive space" is a statement which may mean something different to me than to that participant, or

something different to you, the reader. I am filtering each statement I read on transcripts or in journal entries through my own lens, which means amorphous terms, like "professional interest," are interpreted in the way which I understand them, and coded accordingly. Further, what *I* considered to be indicative of a participant's motive(s) is centered in my investigation. It is not unlikely that the participants themselves, or other researchers, may consider other components of participant narratives to be indicative of motive. In Investigation 2, this becomes even more influential as I analyze how the KU NIC comes to generate a collective object. In this analysis, I identified which segments of their (verbal and nonverbal) conversation were relevant in moving them toward their shared object. Thus, my perspective influences not only how data excerpts are interpreted, but which excerpts are treated as relevant data to the analysis.

This interpretation is done from a lens of duality–I position myself as both an insider and an outsider to the work of the local KU, AU, and TU NICs. Notably, my positioning in each of these NICs is different. For the AU and TU NICs, I occupy more of an outsider role. My knowledge about the context and activities of these NICs comes primarily from my communications with other research team members who are more intimately involved with the regular happenings of AU and TU NICs. As such, I have not intentionally undertaken any community-building with the NICs at AU and TU. At KU, I am regularly involved in their NIC meetings and in conversations with the NIC leaders which actively shape the trajectory of their work. Due to prior analysis of qualitative data collected from KU, I have a greater understanding of their history and perspectives at various time periods.

Although there is this familiarity and trust established between myself and the KU NIC members, I still note that I am very much positioned as a researcher in the NIC space. I do not participate in NIC activities unless I am leading them or am explicitly called upon, and function

as a research observer for a vast majority of the time. This differentiation is enhanced by my participation being limited to the Zoom virtual platform, while the NIC members meet in person. My video screen is hidden during meetings unless I am actively speaking to enhance the quality of the Microsoft Teams recording of the room in which the NIC meeting takes place. This (digital) positioning enhances the ways in which I may be perceived as an outsider–a (mostly) faceless digital observer for much of the NIC meetings.

Despite this positioning, the KU NIC participants are aware of many components of my positionality. I made these disclosures during the Fall 2023 semester, in which I modeled an activity for them in which we shared how our identities may inform how we define and perceive rigor in mathematics. My hope was to model vulnerability, and thus I pushed myself to be fairly vulnerable with them in both dissecting my own experiences of privilege and marginalization in that context. Notably, I share identities with a majority of folks involved in the ACT UP Math grant team, including the local NICs–the identities of whiteness and womanhood are particularly prevalent amongst our team and held by many of our participants. In addition, members of the NICs are all somehow tied to the mathematics department at their institution; my current position within a mathematics department therefore informs my ability to relate to their perspectives. However, my identities also diverge from many of our participants. My ability to understand the nuanced reality of what might motivate someone with different identities from my own is limited, particularly when those identities do deeply impact the individual's motives for engaging in the work. For example, I am motivated to work toward equity in part informed by my own experiences of how gender interacts with mathematics experience and instruction. However, my experiences as a cisgender woman, and my interpretations of those experiences, are likely markedly different from the experience of a transgender woman expressing that

"gender identity has been a strong interconnection with my experience as a math learner and math instructor and as a doer of mathematics" (KU) and that this interconnection motivates her desire to engage in the work of the NIC. These data on motives and collective object generation are filtered through my own lens, which includes interpretations relevant to my held identities.

My positionality as a graduate student working within a research-practice partnership has also informed the methodological decisions I've made in this work. One principal influence on these identities on my methodological choices was the decision to not center poetic in this work, although I have growing expertise in poetic transcription and find it an impactful analysis technique for engaging in equity-focused studies (see, for example, Tremaine, 2022; Tremaine & Hagman, 2023; Tremaine et al., 2024). In this particular project, the AU and TU NICs were not receptive to the poetry activities I had designed and piloted to be used in this work; because ACT UP Math is a research practice partnership (RPP), asking AU and TU (the two NICs with whom I had not developed a relationship) to partake in an activity which they felt could not be meaningfully incorporated into their NIC's work felt inappropriate, and would have been a prime example of research priorities superseding those of practitioners: a known area of problematic tension in RPPs (Denner et al., 2019). Consequently, KU was the only NIC who completed the poetry activity. Because I wanted to include data from across all three institutions in Investigation 1, I opted to not include the KU poetry reflections to avoid confusion or overrepresentation of KU perspectives through this additional data source. This eliminated the critical methodology component I had hoped to include in this analysis. While it is briefly mentioned by a participant in Investigation 2, which takes place solely in the KU context, the data gathered from participants' reflections on the poetry is not showcased in this project. Instead, both investigations center dominant methodologies.

The nature of working within a research practice partnership also influenced how I navigated certain tensions which arose between research and practice within the ACT UP Math project relevant to this work. One such issue that greatly informed the direction of this piece was the need to negotiate identifiability with NIC members at AU, KU, and TU. Because of concerns about anonymity, the research team and local NICs decided that, in work coming out of ACT UP Math, no individual's pseudonym would be linked with their social identities in our research writing. The compromise we came to as a team was that the local NICs would collectively reflect on identities which felt salient to their work through a Jamboard activity, and that members of the research team would use that activity to draft a paragraph of their collective NIC positionality which would then be sent back to them for final edits and affirmation. These were the positionality statements from each NIC that I presented earlier in this chapter (Section 3.2). This need to compromise with NIC members' concerns was extremely important in the context of our research practice partnership. However, the inability to link individuals' social identities to their individually expressed motives or dynamics within the development of a shared object effectively eliminated my ability to responsibly use Situated Motivation, my original theoretical frame, because of its explicitly centering of identity in understanding motive (Nolen et al., 2015; Usher, 2018). This resulted in a pivot toward CHAT, which enables meaningful analysis without the necessity of considering *individual* participant identities with relevance to the object-oriented activity of the NIC.

The inappropriateness of using more racial theoretical frames is also relevant to this work and to my positionality. Much of the literature on understanding whose interests are centered in motives for equity work, or how perspectives shift toward more actionable stances in response to equity, explicitly center race (see, for example, Berry, 2015; Liera, 2023). Because the ACT UP

Math project does *not* explicitly center race, but rather leaves decisions of which students' experiences to center up to the individual institutions, using a framing that necessitated an attendance to race as a component of individual motive or shared object development felt inauthentic. In addition, as a white researcher, my lived experience does not reflect knowledge of racial marginalization, and thus my ability to interpret the motives of individuals or conversations within the NIC through a lens which centered the influences of race and racism are limited. While I do bring in certain frames rooted in race into the discussion sections of each investigation (for example, I discuss relation of Investigation 1 to the Critical Race Theory construct of Interest Convergence (Bell, 1980)), I do so with the conscious phrasing of *borrowing* and *learning from* those constructs, without actually leveraging them as a primary theory. This is particularly important in borrowing from Critical Race Theory, due to its emphasis on lived experience. My goal in this work is to maintain criticality while working within a CHAT lens, but due to both the nature of the ACT UP Math project and my own racial positionality, I chose to not primarily leverage a theoretical framing which centers race, and instead reference such theoretical frames in the discussion section to point toward their relevance in interpreting the investigations' findings.

My identities, and the lived experience I have gained as a result of navigating the world with those identities, will inevitably influence this research. I embrace this subjectivity as a necessary part of the research process, and I maintained an action-oriented awareness of my positionality in order to minimize the harm of being a white researcher conducting equity work in mathematics education, particularly as I discuss conceptual frames which center race. Further, I recognize that the complexity of being a member of a research-practice partnership has inherently shaped this work. My aim in this section was to make explicit some of the ways in

which my personal and professional positionalities influence these investigations, though I recognize that there are undoubtedly unseen ways in which my social and professional identities exert subjective influence over these studies. This transparency is important in enhancing the quality of my research, and in personally interrogating (and inviting you, the reader, to interrogate) the ways in which my positionality influences my research processes (Secules et al., 2021). With this positionality in mind, I discuss Investigations 1 and 2 in the following chapters, beginning with Investigation 1 in Chapter 4.

CHAPTER 4: INVESTIGATING INDIVIDUAL MOTIVES FOR NIC PARTICIPATION

In this chapter, I will detail the methods and results of my investigation into NIC members' individually expressed motives for joining the ACT UP Math project through NIC participation by addressing the research question: *In what ways do undergraduate mathematics instructors, students, and administrators motivate their participation in an equity-oriented networked improvement community?* This work leverages a reflexive thematic analysis of individuals' journal entries and interview transcripts, resulting in five themes which motivated participation: *relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives. Each of these motives are explained and contextualized with relevant excerpts of data. I then conclude with a critical discussion of whose interests are centered within these motives, and provide recommendations for ensuring that individuals engaging in equity-oriented reform work in undergraduate mathematics are able to see beyond self-interest and actively promote transformative change.

4.1: Methods

To investigate individuals' expressed motives for NIC participation, I analyzed journal entry and interview data in this work using reflexive thematic analysis (Braun et al., 2023), followed by a member checking process which included additional participant journaling and the collection of rating scale data (Brit et al., 2016). The first phase drew from interview and journal data at Kappa University (KU) and allowed for the development of five motive themes. The second phase involved thematically coding journal and interview data across institutions, illustrating that the five themes proved robust for Alpha University (AU), Tau University (TU), and new NIC members at KU. The third and final phase shared these five themes back with

participants, giving them an opportunity to indicate their identification with each or identify motives that existed outside of representation through these codes. Below, I detail each phase, describing the setting, data collection, and data analysis phases for each.

Because this is a research-practice partnership within which memberships changed over the course of this project, I want to clarify that I will be referring to each NIC by the semester in which it adopted a particular membership composition (see Table 2 for details of which NIC membership iterations participated in each phase). For AU and TU, only one NIC composition at each institution is represented in Phases 1 and 2 of this analysis: the composition of members who participated in Spring 2023. Thus, they are referred to as the Spring 2023 AU NIC and the Spring 2023 TU NIC. KU, however, has two different NIC compositions represented in Phases 1 and 2: the NIC members who participated in the NIC during the Spring 2023 semester *and* the NIC members who participated in the NIC during the Fall 2023 semester. Thus, there are two KU NIC iterations present in this data set; the Spring 2023 KU NIC and the Fall 2023 KU NIC. Four members were present in both iterations of the KU NIC, and are *not* double-counted in this data set, as participants were only asked to fill out the initial journal prompts once. In addition, because interview data was collected in Spring 2023 and *not* Fall 2023, these four student participants are not represented through interview data within this analysis. Thus, across 30 participants, I analyze in this work 30 journal entries and 26 interview transcripts. Phase 3 was conducted in early Spring 2024, at which point the AU and TU NICs had also undergone membership changes, although the KU NIC had been constant since Fall 2023. Thus, for Phase 3, the Fall 2023 KU NIC, the Spring 2024 AU NIC, and the Spring 2024 TU NIC are participants ($n = 25$). There are many NIC members who have been a part of the NIC throughout each iteration, and thus much overlap, but I find it important to note that not all participants in

member-checking provided the data which developed the additional codes; similarly, not all participants who provided initial journal and interview data (from which codes were developed) were included in the member-checking process. To attempt to clarify this myriad of membership changes and how they relate to my data collection and analysis, Table 2 highlights what data is used where, and Figure 7 provides an indication of which phases correspond to different steps of Braun et al.'s (2023) reflexive analysis process.

Table 2: Summary of participants in Phase 1 and Phase 2 of data analysis, stratified by institution and position held. Student identification encompasses both graduate and undergraduate student members.

	Administrator	**Faculty**	**Student**	*Total per Institution:*
Phase 1 (Familiarization, Coding, Initial Theme Generation, and Reviewing and Developing Themes)				
Spring 2023 KU NIC	3	4	0	7
Phase 2 (Refining and Defining Themes & Producing the Report)				
Spring 2023 AU NIC	1	3	4	8
Spring 2023 TU NIC	1	10	0	11
Fall 2023 KU NIC	0	4 (same as Sp23 KU NIC)	4	8 (with 4 same as Sp23 KU NIC)
Total per Position:	5	17	8	30
Phase 3 (Member Checking)				
Spring 2024 AU NIC	0	4	4	8
Fall 2023 KU NIC	0	4	4	8
Spring 2024 TU NIC	1	7	1	9
Total per position:	1	15	9	25

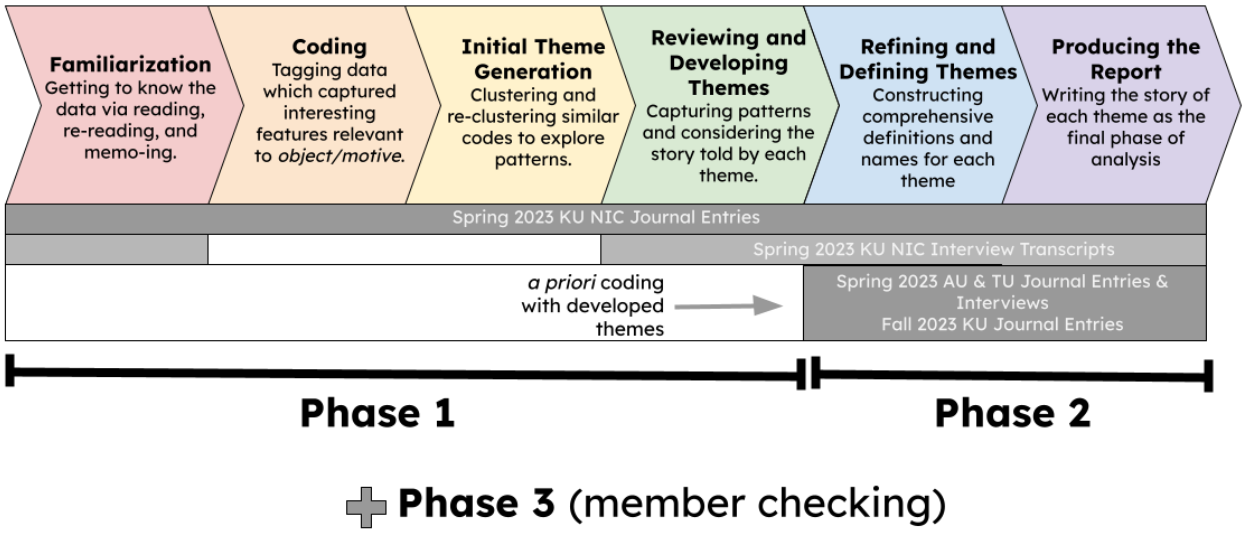


Figure 7. Reflexive thematic analysis adapted from Braun et al. (2023). The bars below detail which components of the data were incorporated into which phases of analysis.

4.1.1: Phase 1 - Theme Development

Theme development began in early Summer 2023, using journal entry and individual interview data collected from the Spring 2023 KU NIC. All NIC members were asked to complete a journal entry at the beginning of Spring 2023 in which they reflected on their own motivations and goals for joining the NIC, alongside reflections about their mathematical journeys and how those journeys connected to issues of DEI. The entire journal entries were considered as data for this study, as expressions of motives for NIC participation appeared within responses to a variety of prompts, not only that which asked explicitly about motivation. Notably, NIC members had the option of submitting their responses to the journal prompts anonymously; several chose to do so. Thus, some quotes from journals are presented anonymously, without attachment to a pseudonym. At the end of the Spring 2023 semester, we conducted individual interviews with each member of the Spring 2023 KU NIC. These interviews were semi-structured (Mashuri et al., 2022) and ranged in length from twenty-five minutes to an hour. We asked participants how they came to join the NIC, as well as how they

saw their role within it, and asked them to reflect upon their experiences following their first semester of involvement. Interview transcripts in their entirety were considered as data for this study.

Data analysis with these data followed a reflexive thematic analysis approach (Braun et al., 2023), detailed in Figure 7. Data *familiarization* was attained through several readings of the KU journal entries, as well as the author's presence and notetaking at many of the interviews followed by read-throughs of KU interview transcripts. Initial read-throughs of the data included memo-ing in a research journal alongside coding and initial theme generation. The *coding* stage was conducted on a subset of the data–the journal entries–and consisted of identifying and writing brief notes alongside excerpts in which participants indicated motives for their participation (Núñez, 2021). *Initial theme generation* allowed for an exploration of patterns in the journal data, resulting in seven themes. These seven themes were then condensed into five with the addition of interview data during the stage of *reviewing and developing themes*, which brought in interview transcripts from the Sping 2023 KU NIC. The resultant five themes were *relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives, which will be detailed in Section 4.2.

4.1.2: Phase 2 - Theme Verification

Following the identification of the five motive themes found in journal and interview data from the Spring 2023 KU NIC's journal entries and interview transcripts, these themes were then tested for robustness across the ACT UP Math project by considering them as *a priori* codes applied to journal and interview data for the Spring 2023 AU and TU NIC members *(n = 19)*, as well as the journal entries of new NIC members from the Fall 2023 KU NIC *(n = 4)*. The journal and interview data for these groups was collected in the same method explained in Phase 1, using

the same prompts and semi-structured interview format. Once more, the entirety of each journal entry and interview transcripts was considered data for this analysis. Although the five themes developed in Phase 1 were considered *a priori* codes, I remained open throughout this analysis to continual refinement and consideration of additional themes.

The five motive themes proved robust for understanding the motives for NIC participation across institutions. No additional themes were added as a result of this analysis. This cross-institutional analysis yielded further verification that these five themes aptly described the motives which led administrators, faculty members, and students to participate in a local NIC. In the *Results* section, I share coded data from these three groups (the Spring 2023 AU NIC, the Spring 2023 TU NIC, and new members of the Fall 2023 KU NIC) interwoven with data from Phase 1 to describe the five identified themes. Table X describes the positions held by participants from both Phase 1 and Phase 2 of analysis.

4.1.3: Phase 3 - Member Checking

In order to further solidify the robustness of the five motive themes, participants in the Spring 2024 AU NIC, Fall 2023 KU NIC, and Spring 2024 TU NIC *(n = 25* across the three institutions*)* completed a journal entry focused on reflecting on these five themes. In a process in line with what Birt et al. (2016) describe as a "member check using synthesized analyzed data" (p. 1084), participants had an opportunity to indicate whether they felt these themes were salient to their own perceptions of their motives for joining the NIC and provided space to expand on motives which they felt existed outside of the five identified themes. For purposes of this final phase, I consider two pieces of data collected in this journal entry: a rating scale of identification with each of the five motives, and a free response prompt intended to elicit reflections on

motives which could exist outside of the five identified themes. These data were collected via the Qualtrics online survey platform.

With an awareness of participants' limited time to dedicate to the member check process (Birt et al., 2016), a rating scale was used to ascertain data around the resonance of the five themes. Participants were provided with the name and a brief description of each of the five themes. They were then asked to select a response to the question, "To what extent does each of the following motives resonate with your reasoning for joining the NIC?" Participants could select "Not at all," "Very little," "Somewhat," or "To a great extent." Immediately following this rating scale, participants were provided with a free response opportunity to identify any motives they held which were not represented by the motive themes provided via responding to the prompt "Are there any other motives that resonate with your reasoning for participating in the NIC? If so, please explain." Participants could either type or record audio in response to this question.

As Birt et al. (2016) point out, a major limitation of this method of member checking is that analysis must be completed prior to returning the themes to participants, increasing the time between initial data gathering and member checking, and thus increasing the likelihood of losing participants. Between the original identification of the themes (Spring 2023) and the distribution of these themes to participants for response (early Spring 2024), all three NICs underwent membership changes. As it was deemed inappropriate by local NIC leaders to reach out to prior NIC members with the opportunity to member check, these data in Phase 3 are limited in that they reflect only the perspectives of individuals involved in the ACT UP Math local NICs during Spring 2024; the entirety of the NIC members from whose data these codes were developed and verified were not wholly included in the member-checking process. Due to the robustness of the

codes across institutions and within changing participation, I recognize this limitation and still see fit to present this member checking data as an important component of analysis.

4.2: Results

The results of the study of individuals' motives for NIC participation are provided below. The first section, *Five Motive Themes*, details findings from Phase 1 and Phase 2 of the analysis, in which journal entries and individual interview transcripts from 30 NIC members across three institutions were analyzed to create robust illustrations of the five themes. A total of 190 independent excerpts from the data were coded within these five themes; selected excerpts from across all four NIC iterations at all three institutions are provided as evidence for each theme. Most NIC members expressed motives from more than one theme, and in several cases motives were double- or triple-coded. If a participant expressed a similar idea in both their journal and interview, these were considered independent excerpts as they were expressed in different data collection settings in response to different prompts. The second section, *Member Checking*, showcases responses to the rating scale, and discusses participants' written understandings of the five motive themes' saliency after reading brief descriptions of each. I also remind the reader that some participants submitted their journal anonymously, and thus not all quotes have an attributed pseudonym. Further, an anonymous attribution is also given to quotes which specify a particular social identity of the NIC member, enabling the maintenance of anonymity as agreed upon between AU, KU, and TU NIC members and the ACT UP Math research team.

4.2.1: Five Motive Themes

This section describes in detail the five themes which arose from the original reflexive thematic analysis (Braun et al., 2023) on the Spring 2023 KU NIC journal entries and interviews, and their refinement through the journal entries and interviews from the Spring 2023 AU NIC,

the Spring 2023 TU NIC, and the Fall 2023 KU NIC. Table 3 provides an overview of each theme by including the name of the identified theme, a brief definition of what is encompassed by that motive, and an example from the data which falls into that theme.

Table 3. An overview of the five themes for NIC members' motives for NIC participation.

Theme	Definition: *Expressions of reasoning for NIC participation which…*	Example from Data
***Relational* Motive**	Center participants' desires to maintain and develop their relationships with folks involved in the NIC, research team, math department, or institution more broadly.	"I really like just being involved in different groups. I'm in a couple of other communities of practice, and stuff. I'm in a couple of other groups with the faculty. And so I think it's just really fun to be involved in those groups." (Chelsea, AU)
***Self-improvement* Motive**	Center participants' desires to grow in their knowledge of equity and equity issues, and grow in their own skills as practitioners of mathematics education.	"This new generation is changing a lot, and we cannot do the same things that we did before, like teaching and stuff. And I just want to be on top of things and be updated on the latest recommendations, successes, and all of that." (Sabrina, TU)
***Student Experience* Motive**	Center the idea that participation in the NIC could improve the ways in which students experience mathematics at the classroom, institutional, or societal level.	"Gender identity has been a strong interconnection with my experience as a math learner and math instructor and as a doer of mathematics. And I want to bring that perspective to contribute to better math instruction in the future for all young mathematicians, but in particular for Queer mathematicians." (Anonymous, KU; double-coded with *Influence*)
***Influence* Motive**	Center participants' desires to have an influence on the policies and practices of the department or institution.	"I was excited that the conversations and solutions we come up with in NIC would have the opportunity to be included into practice and policy at [KU] instead of solely staying a journal/research article that, fingers crossed, someone will randomly come across." (Stella, KU)

***Values to Action* Motive**	Center participants' desires to enact personal or professional values they hold related to equity, diversity, and inclusion, or values around mathematics or mathematics teaching and learning.	"I have always cared very deeply about education (mathematics and otherwise) and even more so about the intersection between education and social issues." (Taylor**,** TU)

Relational Motives. Motives coded as *relational* centered participants' desires to maintain and strengthen relationships with folks involved in the mathematics department or research team through participation in the NIC. These motives framed the NIC as an opportunity for community-focused work or community-building. Positioning this motive temporally, one might observe that NIC members are coming off of several years of remote or partially remote work due to the COVID-19 pandemic. Several NIC members explicitly named this when motivating their NIC participation. One TU NIC member stated, "especially coming off the pandemic, I feel a distance from my colleagues. I would like to take a more proactive approach toward working with colleagues and building connections and relationships." Another participant, Juniper (KU), expressed a similar sentiment by positioning NIC engagement as a form of personal and professional recovery from the pandemic:

> Honestly and most personally, you know, we're still recovering from COVID, professionally, institutionally. I wanted an opportunity to sit and have deep and meaningful conversations with other really, really smart women…these are women I admire, whose work I respect. And I frankly love talking with them about big ideas and education.

Juniper (KU) also noted that, as an administrator, she had seen many transdisciplinary connections disintegrate during "the COVID years", and thus expressed a desire to "firm up a network of collegial relationships" via NIC involvement.

The opportunity to maintain positive social and professional connections to others was particularly prominent in NIC members' motives for participation. Skylar (KU) explicitly stated that one goal motivating her participation in ACT UP Math "is to deepen my relationships with the NIC members and the ACT UP team, particularly those from outside my department." Student participants Chelsea (AU), Mallory (AU), and Ricardo (KU) all drew on existing feelings of connection to members of the mathematics department as motivating their participation; student participant Chelsea (AU) remarked that she "was thrilled to have the chance to work alongside some of my old professors and other classmates." Many of the faculty and administrative participants drew on respect and admiration for specific colleagues, in particular their local NIC leaders, to motivate their NIC participation. Senna (KU) and Travis (TU) both saw their trust in NIC leaders as a motivating factor for their participation, even when they knew very little about the NIC or ACT UP Math project as a whole. Senna expressed that she "generally just respect[s] Tiersa too, so I figured even if it [the NIC] didn't sound great, it probably would be." Travis indicated his NIC participation was built on trust that his colleagues, NIC leaders Katie and Olivia, wouldn't "steer [him] in the wrong direction." Still others noted that their respect for NIC leadership, as colleagues and as practitioners, motivated NIC involvement. Lisa (KU) remarked that she "greatly respects the faculty who are leading KU's NIC" and attributes her participation to the knowledge that the leadership team are "known for being caring and innovative teachers." Juniper (KU) described having built up a working relationship with Skylar through a different university-wide project, noting that she "loves how Skylar approaches her work, and anything Skylar asks me to do, I will do," which she connects to her enthusiasm for participating in the NIC. This same sentiment was expressed almost identically by Lisa (KU), who noted that when Tiersa or Skylar ask her "to do something, [she's]

going to say yes, because of them and who they are." Kayla (TU) noted that she "joined this NIC…because [they] enjoy working with the colleagues that facilitate the NIC." This desire to maintain and strengthen pre-existing positive relationships with NIC leadership was salient in how participants motivated their NIC participation.

Building new relationships also factored into participants' motives for NIC participation, often due to the new perspectives they yield through the opportunity to have conversations with folks outside of one's immediate professional sphere. Kayla (TU) expressed the following about having non-faculty members within the NIC:

> I just like…being able to engage just as a participant equal with my peers, and getting to hear from people that don't teach college…I don't meet with them and discuss these things as often, so I think it's really interesting to be with people I don't usually get to talk about teaching math with.

Sabrina (TU) also expressed a desire to hear a diversity of perspectives, particularly around equity-oriented issues and actions. She shared in her interview that "[she] would really like to hear what other colleagues are saying about these issues, because we have some important issues in education right now. And [she] really want[s] to see what they're doing, what they're thinking about." The opportunity presented by ACT UP Math NIC participation to engage collaboratively functioned as a pathway to novel perspectives, which these participants cited as motivating involvement.

In a very general sense, NIC members also rooted their motives for joining the NIC in a desire to be a part of a community-focused effort. Kiara (KU) made the potent observation that community-oriented efforts have not historically been a part of her experience or observation of mathematics department work in the following statement:

> I'm excited by what I perceive as a very community-oriented effort…community organization as a tool for change is something I've increasingly found myself engaging with in my personal life…I'm excited by those skills entering my workspace and entering a space that I feel historically hasn't been as community-oriented as it could be.

Timothy (KU) also identified the power in having a team (contrasted with his own efforts as an individual) focused on implementing change as an important factor in why he joined the NIC, and Chelsea (AU) expressed that "it's just really fun" to be involved in groups with faculty.

For some participants, NIC participation provided an opportunity to continue a pre-existing sense of community. Opportunity to engage in the ACT UP Math project was introduced near the end of previous NSF projects at each institution: SEMINAL and PtC. The opportunity to maintain relationships afforded by involvement in another large-scale project served as a motivator for several NIC members. Both Angela and Caroline, leaders of the AU NIC, saw participation in the ACT UP Math NIC as an opportunity to maintain relationships with "a lot of the same people" (Caroline) who were involved in the *SEMINAL* project, and continue to "work together on what changes can we make in the classroom" (Angela). Skylar (KU) mentioned that her arrival at KU coincided with the tail end of the *Progress through Calculus* project, noting that she was able to develop a relationship with one of PIs of the ACT UP Math project, and was excited by the opportunity to continue that relationship through involvement in ACT UP Math. Skylar was not the only participant to express a desire to build or maintain relationships with the research team specifically; Caroline (AU) also expressed that she was "excited about connecting with the larger [ACT UP Math project] NIC, which is something that [she] gets to do as the liaison between [her] department and the research team" through her positioning as a NIC leader.

Olivia (TU) provided an additional relational dimension of larger ACT UP Math NIC involvement, in which she referenced the social positioning of NIC participants within the mathematics department as a whole, connecting it to a desire to see a similar relationship with the mathematics department arise as a result of involvement in the ACT UP Math project. She observed the following:

> One of the things that was nice about the SEMINAL project is that there were faculty who were involved, and they became seen by the [mathematics] department as leaders and resources, and I wanted to do that again, with perhaps a different group of faculty, to try to equip the department with more people who could help move the department forward.

In this excerpt, Olivia detailed a dimension of relationality related to her experiences with the SEMINAL project, noting that she would like to see similar relationships take hold as a result of ACT UP Math. Through observations about the anticipated collaborative nature of the ACT UP Math project the opportunity to be a part of community-oriented action was salient in motivating NIC members' participation.

By the time of the journals and interviews collected for this study, participants were all aware that involvement in ACT UP Math would be collaborative. The emphasis on this attribute of the project likely made space for participants to consider it an opportunity for relational development, and this consideration was reflected in the motives they expressed. This opportunity to maintain and strengthen pre-existing relationships, often built on prior positive social and professional encounters, motivated their desire to get involved.

Self-Improvement Motives. In this theme, participants discussed the ways in which they were motivated to join the NIC in order to experience some level of self-improvement. This took

two primary forms: growing in their knowledge of equity and equity issues, and growing in their own skills as practitioners of mathematics education. With regard to growing their own equity knowledge, many participants positioned the NIC as a professional development opportunity in which they could learn various things about equity-oriented topics. This was especially salient for several members of the TU NIC; topics of interest included "equality versus equity" (Anonymous, TU), "current DEI research and best practices" (Kayla, TU), and "how math is diverse and how diverse today's mathematicians are" (Anonymous, TU). Ethan (TU) motivated his participation by describing his own uncertainty about how students' diverse identities play a role in their mathematics experience:

> It's not really clear to me how a student's background, especially things like race, gender, or socioeconomic background, influence how said student learns best. I had thought, as a lot of people do, that math was mostly oblivious to demographics…I'm very curious as to how it is that mathematics is NOT oblivious to demographics, so this is part of my motivation for joining this NIC.

Outside of the TU NIC, participants also expressed a desire to learn more about equity issues either specific to their institutions or within US society more broadly. Anna (KU) recognized her own awareness of systemic issues and barriers faced by students who hold marginalized identities, while simultaneously indicating that she sees NIC participation as "a chance to be exposed more to issues that I don't know about now (or haven't thought about yet) that influence my students."

Beyond improving knowledge related to equity within mathematics, several participants were motivated to join the NIC due to the opportunity to engage with equity work, full stop. Both Kayla (TU) and Garrett (TU) conceptualized NIC participation as a way to make space for

reflection and purposeful time spent "think[ing] critically about issues of diversity, equity, and inclusion" (Garrett, TU); while not pointing to any particular dimension of DEI in mathematics, their motives to join the NIC connected more generally to an opportunity to have dedicated time and space to devote to considering these issues. These excerpts provide illustrations of the ways in which NIC members viewed NIC participation as a mechanism through which to improve their own understandings of equity issues within undergraduate mathematics.

The most common way in which this theme manifested in folks' motives was through a focus on improving one's own professional skills as a practitioner of undergraduate mathematics education. One form this took was in the context of improving one's own professional skills related to teaching or administrative work, often in relation to inclusive practices in their own mathematics classrooms. Involvement in the NIC represented an opportunity to "implement and address structural inequalities…in my own classroom" (Travis, TU), "improve my teaching and student success" (Sabrina, TU), and "understand how I can support enhancing math education" (Lisa, KU). Mallory (AU), an undergraduate student who is not presently teaching, sees the value of the NIC participation to her professional growth, noting that she "wanted to be a part of [ACT UP Math] because I want to be a math teacher and have always been interested in how I could improve teaching methods once I start." Caroline (AU) discussed how she saw joining the NIC as an opportunity to "continue to develop as a teacher and to keep growing as a facilitator of professional development and coordinator for lower division courses," citing many dimensions of her professional role within her department and connecting them to her reasoning for leading the NIC. The data-driven nature of the ACT UP Math project also factored into the opportunity for professional self-improvement afforded by the NIC. Kiara (KU) expressed the following:

> I am also really excited to simply learn what data informed changes I can make as an individual in my own teaching…it's exciting to have conversations about the changes that people are considering, what they're finding works and doesn't achieve particular goals. And I'm excited to simply learn from that and to not only see that operate on systemic levels, but also to enact that in my own instruction.

For Kiara, NIC involvement presented an opportunity to learn from others through dialogue, analyze changes on a systemic level, and then bring those findings into her own undergraduate mathematics classroom. An AU NIC member noted that NIC involvement could enable them to "apply different teaching techniques and be able to back up each style with research in the future," indicating that she is motivated by the opportunity to bridge research and practice, a sentiment mirrored by Kayla (TU)'s expressed desire to learn "how to use DEI related data to inform practice." Sabrina (TU) shared a similar sentiment regarding learning more about connecting her teaching techniques to research, and positioned this learning as necessary for the current educational environment:

> There are numerous challenges that affect the education profession these days. I feel that a major revision in this field is imminent, and it will be coming sooner than expected. Personally, I would like to be prepared for it and one way of doing that is to be engaged in projects that address some of its current challenges.

In her interview, she elaborated on this perspective, indicating that NIC participation offered an avenue through which she could "be updated on the latest recommendations, successes, and all of that" to ensure that her teaching was top-notch and that she was prepared for any shifts to come in undergraduate education. Overall, NIC members placed tremendous motivational value

on an opportunity to improve their professional skills, particularly as mathematics instructors and administrators, when considering NIC involvement.

A desire to improve one's own professional skills also included a desire to learn more about mathematics education research through involvement in the ACT UP Math project. Mallory (AU), a student participant, described her reasoning for applying to join the NIC in the following way:

> I'm only really interested in anything to do with math education. So I was like, okay, sure, I'll fill out the form, and find out a little bit more about what I can do…I thought [the NIC] would be a nice introduction into [research-related activities].

Other members of the NICs expressed a similar sentiment. Kayla (TU) noted that she "like[s] the act of researching," and that the opportunity to conduct research on her own teaching was of particular appeal. This was also salient for her colleague Ethan (TU), who wrote that he joined the NIC "hoping to part out some small project in my own classes, maybe even something that is research 'light'." One TU participant wanted to bring a scholarly approach to issues of equity, citing a desire to "learn how to study and critique topics in pedagogy, and eventually produce scholarly work" in the field of mathematics education. On a more macro level, several members cited ACT UP Math's status as a large, NSF-funded research project as a particular setting from which they were hoping to learn. Skylar (KU) noted that she "also hope[s] to learn more about education research and working on a big federally funded project (and have already learned a lot)," presumably citing what she had already learned working with the ACT UP Math research team in preparation for leading KU's local NIC. Angela (AU) saw involvement in ACT UP Math as a way "to better understand the data we have on hand for lower division math courses and what is a good way to dig deeper into the data," insinuating that the opportunity for guidance

from a mathematics education research team with experience analyzing large datasets was of interest. Her co-leader, Caroline (AU), also expressed that engagement with the ACT UP Math research team could result in "support in engaging in some of the things we've been working on with a little more intentionality", referencing the ways in which ACT UP Math participation could formalize some of the conversations that she and other NIC members were already having about enhancing equity within their department. For these NIC members, being a part of the NIC was motivated by the opportunity to grow in their understanding of mathematics education research and processes.

NIC members across these three institutions saw NIC participation as an avenue for personal and professional growth. Areas of this growth included knowledge about issues of equity, diversity, and inclusion, knowledge about teaching practices, and knowledge about mathematics education research. Within these motives, the NICs are positioned as professional development opportunities in which NIC members can learn and grow with each other and with the research team in knowledge around equity and skills related to undergraduate mathematics education.

Student Experience Motives. This theme encompasses motives which center on the idea that participation in the NIC could function to improve the ways in which students experience mathematics at the classroom, institutional, or societal level. Statements exemplifying this theme place students at the locus of benefit of NIC involvement, and explicitly attend to components of student experience including sense of belonging, grades and measures of success, and classroom experience. Motives for NIC participation that fell into this theme included "supporting students of diverse backgrounds" (Jordan, TU), "embrac[ing] and actively includ[ing]" students who hold marginalized identities (Juniper, KU), and enabling students to "approach mathematics and not

be afraid of it" (Kayla, TU). Many participants relied on understandings gained from mathematics peers or students at their institutions to develop an awareness of the need to improve student experiences, which in turn informed their NIC involvement. Chase (AU), a student himself, shared that both he and many of his friends have persistently struggled in math. His own attitude toward math turned around in a freshman geometry course, and he expressed that through his NIC involvement, he "want[s] to give people that opportunity to continue math and not, I guess, hate it in a way." From an instructor perspective, Tiersa (KU) motivated her NIC participation by referencing a similar perspective which she hears from students:

> I'm also motivated by the negative reputation that the math department has throughout [KU]...Anecdotally, I believe students view the introductory courses as weed out courses designed to get them to quit math/STEM if they're not 'cut out' for it. But I have found math beautiful and rewarding…I want math classes to be a positive experience for the students who are required to take it, and an opportunity for joy for the students who take it voluntarily.

By contrasting student anecdotes she has heard about the gatekeeping nature of student experiences in KU mathematics with her own understanding of mathematics as "beautiful and rewarding", she identifies that a component of her motivation for doing this work is to shift student experiences toward positivity and joy. Senna (KU) also noted that she hears from her students who feel they are "bad at math" and thus hesitant to see themselves as mathematically capable. She hoped that getting involved in the NIC could help her "confront this head on or at a broader level."

In addition to targeting students' feelings about mathematics and about themselves as mathematicians, NIC members also focused on adjusting classroom and institutional environments to better support students. One KU student member expressed:

> One of my main goals is to ensure that students are inserted into an environment where they don't feel pressured into taking on more than they are prepared for…I'd like to participate in fostering an environment where students who come from different backgrounds, and maybe haven't received a sufficiently thorough and/or formal math education, can feel comfortable to collaborate with other students who have had opportunities to gain more of this knowledge previously.

This NIC member recognizes the need for enhancing the experiences of KU students with diverse mathematical experiences prior to their introductory math courses, and sees participation in the NIC as a way to create such an environment.They express this perspective after highlighting their own experience- that of an international student who didn't have an opportunity to take anything beyond precalculus in high school, but coming to the U.S. to attend a school (KU) where calculus 1 is the expected introductory course. Anna (KU) also drew on her personal experiences when she expressed a facet of her intentions for joining the NIC:

> I feel like I was raised in a household culture that doesn't really empower students or kids to advocate for themselves. Especially in a way that I see students doing a lot now…People are sort of navigating this hidden set of rules of how to advocate for themselves in a way that makes things really unfair to people who either don't know to ask those questions or see something really unfair about asking for basically any kind of exception.

Explicitly naming this as a "hidden curriculum" in higher education, Anna shared that she is "really fired up" about this facet of the student experience and wanted to address it through NIC participation. By identifying and discussing aspects of students' undergraduate mathematics experiences, the participants point toward the need to foster more positive student experiences in these mathematical contexts as reasoning for why they are joining an equity-oriented NIC.

Influence Motives. *Influence* motives were reasoning for NIC participation which expressed a desire to personally impact policy and practice at the department or institutional level. In the words of Skylar (KU), influence motives reflect a desire to "be a part of the solution in improving our equity, diversity, and inclusion." Often, these were expressed as fostering change in general, such as a desire to "move the needle in these [introductory mathematics] courses" (Angela, AU) or to "implement policy and changes to make involvement with the math department more equitable for all students" (Timothy, KU). Some folks identified specific aspects of undergraduate mathematics they were hoping to change. For example, Tiersa shared that she "was excited about an opportunity to think about grading and assessment and how that hasn't maybe been going really well at [KU] and ways that we could change it." For Anna (KU), this looked like a desire "to do something, or talk more at least, with colleagues about why" KU students have such a negative impression of the KU mathematics program.

Influence motives also included instances in which participants expressed a desire to have their perspective represented in decision-making spaces through involvement in the NIC. Mallory (AU) recognized that her unique perspective as a student and as a department tutor could "give a different perspective to the NIC," as did her NIC student colleague Chase (AU), who emphasized that he felt he could "provide that student aspect, sharing my experiences and

what I can see around myself and with other students." Sabrina (TU) also drew on a desire to share a unique perspective:

> I think that I can bring different perspectives just because of my background. I come from a different culture, and I see things a little bit different than maybe my colleagues who come from other cultures. So maybe I can bring something that is unique on the table.

Sabrina recognized that the NIC is an avenue to share her culturally rooted perspectives, and she drew upon this to motivate her participation. One KU NIC member also notes that, as an international student who "wasn't ever given the option to learn math in school past pre-calculus", he can bring "a valuable perspective into conversations of this NIC." Another KU NIC member indicated that the opportunity to bring their "distinct perspective to the NIC as a transgender, pansexual, first generation" person "to contribute [their] perspective to that body of understanding of what changes might be most pressing" for the NIC to address was salient to their reasoning for joining the NIC. These excerpts demonstrate the ways in which some of the NIC members motivated their NIC participation with the knowledge that they had a unique and valuable perspective to bring into their local NIC.

Several participants also saw the NIC as an avenue for making actionable change within their departments, and contrasted the NIC with other programs or change avenues which did not feel as responsive to issues of DEI. Connor (TU) detailed this contrast in the following passage:

> Ultimately, I had received probably six different presentations on the importance of equity and inclusion, and zero of these presentations had any meaningful information on things to actually do in the classroom. I joined the NIC to see if I can contribute to actionable items in the classroom…I would like to assist in coming up with actual,

> actionable items that people can use in their classes to help students from underrepresented backgrounds.

Seeing the NIC as an avenue for actionable items spurred Connor's involvement. Juniper (KU) drew a similar contrast between the NIC's work and other DEI-focused work she was involved in around campus, noting that in contrast to the "conceptual" work of these other groups, "the math faculty [in the NIC] are doing 'grassroots' work in the classrooms, in the labs, in the help rooms." This departure from more theoretical equity work also proved salient for Stella (KU), who shared that she "was excited that the conversations and solutions we come up with in the NIC would have the opportunity to be included into practice and policy at KU instead of solely staying in a journal/research article that, fingers crossed, someone will randomly come across." These participants saw the NIC as an avenue for making real influence, and drew contrasts between the NIC and other institutional efforts as they motivated their participation.

Notably, this theme also included instances in which NIC members cited a desire for influence on the broader department or university community through their NIC involvement. This was particularly salient for folks who held administrative roles. Juniper (KU) shared that she hopes to "take insights [from ACT UP Math participation] back to our big curriculum committee so that we're integrating math education into our new curriculum thoughtfully," indicating that she felt her NIC participation could have an influence beyond the math department. Similarly, Kayla (TU) connected their role as course coordinator to their NIC involvement:

> As a course coordinator, I hope to use what I've learned from participation in this NIC to help other instructors improve their interactions with their students…I would like to share

> what I learn from my experience in this NIC to support instructors with the goal of influencing student success in introductory mathematics.

The idea of supporting the instructors that they interact with through their role as course coordinator enables a broader influence stemming from their participation in the NIC. Another KU administrator, Stella, shared that the NIC presents an opportunity to "create novel change that excites people across [KU] to create similar ACT UP/NIC opportunities for other departments/programs." While Stella, unlike Juniper and Kayla, did not position herself as a vessel for this knowledge expansion, her desire to join the NIC included the knowledge that NIC work can have this broader influence.

For many NIC members, participation in the NIC represented an opportunity to "make some real changes in the department" (Skylar, KU), and this opportunity for influence was a distinctive theme in their motives for NIC participation. Representing unique perspectives in NIC decision-making, being involved in general or specific shifts in undergraduate mathematics education, or the opportunity to be a part of impacts within and beyond the mathematics department proved salient for many NIC members.

Values to Action Motives. *Values to Action* motives were instances in which participants indicated that their desire to engage with the NIC stemmed from alignment with a value or belief they held related to their role or to DEI in general, and a desire to see that value enacted at their institution. For example, Lisa (KU) stated that she "believe[s] that addressing DEI in mathematics courses at [KU] is important, and I am happy to support this effort." Sabrina (TU) expressed that she is "really passionate about all [things] related to teaching," and thus saw the NIC as an opportunity to enact this passion. Kiara (KU) called out such value alignment explicitly as a motivator in the following excerpt:

> I think there's also this layer of, kind of the values that I hear the NIC operating with as aligning with my values…for example, my understanding is there's an emphasis on data-informed change…this idea of using data science as a tool for justice, like transformational change is, in my opinion, really incredible and something I've been really excited about. So I'm excited to be involved in a project that is leveraging that at the level of math instruction.

The parallel between the NIC's rhetoric around making data-informed transformative change and her own passion for this idea factored into Kiara's decision to get involved in the NIC. In another detailed example shared in both her journal entry and interview, Taylor (TU) rooted a part of her motives for joining the NIC in her prior experience teaching mathematics within the prison system, and how that drove her passion for "education (mathematics and otherwise) and even more so about the intersection between education and social issues." She shared that she saw the NIC as "a good avenue for the same sort of feelings" that she had about the importance of teaching mathematics within the prison system. Drawing on passions or values developed through prior experiences motivated some NIC members' engagement with the NIC.

Some of these motives were rooted specifically in values and beliefs around the teaching and learning of mathematics, or values of beliefs regarding mathematics as a discipline. When asked to share how he came to be involved in the NIC, Travis (TU) shared that he "just ha[s] a passion for math," and similarly, Lisa (KU) drew on mathematics being "near and dear" to her when elaborating on the "commitment to improving students success" which brought her into the NIC. Ethan (TU) shared that coming to understand that math "isn't quite as demographically blind as [he] wants" informed his desire to get involved with the NIC. Anna (KU) shared the following motive rooted in her beliefs about the power of mathematics:

> I also feel like mathematical skills are so powerful and that, when students really understand what they're doing mathematically, they can gain confidence in their wider STEM abilities but also use these problem solving skills to approach a much broader range of problems than when they simply approach problems mechanically.

She connected this assertion to a desire to address "practices, systemic issues, and other barriers that penalize some students and advantage others," and saw the NIC as a way to consider avenues for correcting these. Similarly, Sabrina (TU) shared that she sees mathematics as "something that help[s] us to live better" and that therefore mathematical skills "are really important for students". In these excerpts focusing on equity reform in mathematics specifically has particular value, and the NIC was viewed as a vessel through which to enact this disciplinary valuation.

These motives were cases in which participants indicated that their desire to participate in the NIC stemmed from alignment with a value they hold related to DEI, mathematics, or the intersection of the two, and a desire to see that value enacted at their institution. Participation in the NIC was positioned as a way to enact held values. These values may have arisen from different experiences (for example, Taylor's experiences teaching in the prison system), but were readily connected to NIC participation. Since the NIC presumably shares the values these participants express, they see it as a suitable outlet through which to allow their values to take actionable form and this acts as a motivating factor for their participation.

These five motive themes, described using journal and interview data from Spring 2023 KU NIC, Spring 2023 AU NIC, Spring 2023 TU NIC, and Fall 2023 KU NIC participants, were not necessarily disjoint, and many excerpts were double- or even triple-coded. Consider the following quote from Olivia (TU):

> I really believe that active learning makes a difference for student learning, and I've seen that in the previous work. And so I wanted to continue to think about how to improve undergraduate mathematics education experiences for students, as well as outcomes.

This excerpt of Olivia's interview was coded as both a *values to action* motive and as a *student experience* motive. Similarly to how other participants with *values to action* motives drew on a valuation of mathematics as a discipline, Olivia drew upon the value that pedagogy can hold for student learning. Placing high value on pedagogical techniques served to motivate her desire to work within the NIC with the explicit focus of improving student experiences and outcomes. *Student experience* motives were certainly the most common motive to be double-coded, although this motive was only tagged if the motive explicitly indicated an orientation toward student experience. For example, Kayla (TU) noted that, through their NIC participation, they are "interested in learning more about current DEI research and best practices and how those might apply to my student population." Kayla's motive to learn more about these issues and consider how they apply to their classroom setting may result in benefits for student experience–an instructor who knows more about DEI research may be more likely to put such research into practice–but without an explicit desire to improve an aspect of student experience, this excerpt remains solely coded as *self-improvement* due to the speculative nature of how Kayla might (or might not) use that enhanced knowledge to improve students' experiences. Consider instead an excerpt from Timothy's (KU) journal entry, in which he expressed wanting to be a part of "implement[ing] policy and changes to make involvement with the math department more equitable for all students" through NIC participation. Timothy's desire to personally "implement policy and changes" points toward an *influence* motive, with the explicit orientation of ensuring that students are invited into equitable involvement with the math department–a facet of student

experience in undergraduate mathematics. This excerpt was double-coded as both an *influence* motive and a *student experience* motive. Perhaps unsurprisingly, *student experience* and *influence* were the motives which were most commonly double-coded with others. Student experience also readily exists as a possible implicit motive, as in the case of many of the *self-improvement* motives. An instructor or administrator's desire to learn more about equity or inclusive teaching practices in particular could serve to benefit student experience should that knowledge be enacted, but if enacting such knowledge for the purpose of improving a facet of student experience was not explicitly stated in the motive, it was not double-coded.

A quantification of the number of excerpts coded for each institutional NIC across the five themes is provided in Table 4. While this quantification erases the richness of different excerpts, it is helpful for revealing overall trends in what participants are attending to when they motivate their NIC participation. Although no single motive appeared especially dominant across all three institutions, zooming in on any one NIC reveals trends in the motives expressed by that particular NIC. For example, the Spring 23 TU NIC brings into their work an especially high concentration of *self-improvement* motives. For the Spring 23 AU NIC, *student experience* motives were *not* especially prevalent. We can also consider the shifts in motives which took place between the Spring 23 KU NIC and the Fall 23 KU NIC; in adding four student members to their NIC and discharging the administrative members, they saw a greater amount of *student experience* motives among the individuals within the KU NIC. A limitation in analyzing these trends is an inability to account for the richness of the excerpts or consider the detail or strength of identification with each motive; this provides the foundation for the member checking detailed in the following section, in which NIC members are given the opportunity to self-identify with the five motive themes.

Table 4. A quantification of excerpts coded across the five themes and four NIC compositions. Total values for each column are expressed in parentheses as a percentage of the total 190 unique excerpts coded from interviews and journal entries which included that code.

	Relational	**Self-improvement**	**Student Experience**	**Influence**	**Values to Action**
Spring 23 AU NIC	9	9	2	7	10
Spring 23 KU NIC	15	8	10	14	12
Spring 23 TU NIC	12	25	8	3	9
Fall 23 KU NIC	12	7	14	12	12
Total	48 (25%)	49 (26%)	34 (18%)	36 (19%)	43 (23%)

4.2.2: Member Checking

This section provides an overview of participant responses when presented with the five themes developed above. 25 individuals across all three institutions (the Spring 2024 AU NIC, the Fall 2023 KU NIC, and the Spring 2024 TU NIC) were provided with a brief description of each motive theme (see Table 5 for the description provided), and were asked to identify the extent to which each motive resonated with their own motives for participating in their local NIC using a rating scale with the options of "Not at all," "Very little," "Somewhat," and "To a great extent." These brief definitions were generated collectively at an ACT UP Math research team meeting, in which several members of the research team consulted more extended definitions and shortened them. NIC members were then provided with an opportunity to provide a written response to the prompt, "Are there any other motives that resonate with your reasoning for participating in the NIC? If so, please explain."

Table 5. The brief definitions of each motive theme provided to the participants.

Motive	*Description Provided to Participants*
Relational Motive	To strengthen relationships with others

Self-Improvement Motive	To learn more about equity or grow professional skills related to DEI
Student Experiences Motive	To improve student experiences in mathematics at my university
Influence Motive	To influence department/university policy and practice
Values to Action Motive	To enact personal or professional values

A visual depiction of how participants responded to the rating scale is provided by Figure 9 in the form of a stacked bar chart, as recommended for rating scale data by Robbins and Heiberger (2011). Only one participant selected "Not at all" in their response to any of the five motives, and notably *all* participants selected either "Somewhat" or "To a great extent" with regard to the resonance of the student experience motive, although only 17 out out of the 30 NIC members across the four was originally coded as expressing a student experience motive.

A visual depiction of how participants identified with these motives is provided by Figure 9. Participants overwhelmingly resonated at least "Somewhat" with the five motives as described. Of the 125 (25 participants by 5 motives) marked participant responses, "To a great extent" was selected 67 (54%) times, and "Somewhat" was selected 44 (35%) times, with "Very little" selected 13 (10.4%) times, and "Not at all" selected once (0.8%). The relational motive was indicated as the least resonant for participants, with 6 (24%) selecting "Very little." Notably, *all* participants selected either "Somewhat" or "To a great extent" regarding the *student experiences* motive, with the vast majority (23; 92%) selecting "To a great extent." Participant responses to the *self-improvement* motive also indicated substantive resonance, with 24 (96%) responses selected as "Somewhat" or "To a great extent." Overall, this acts as evidence that these five themes were aligned with participants' own perceptions of their motives, with particular emphasis on the *student experience* and *self-improvement* motives.

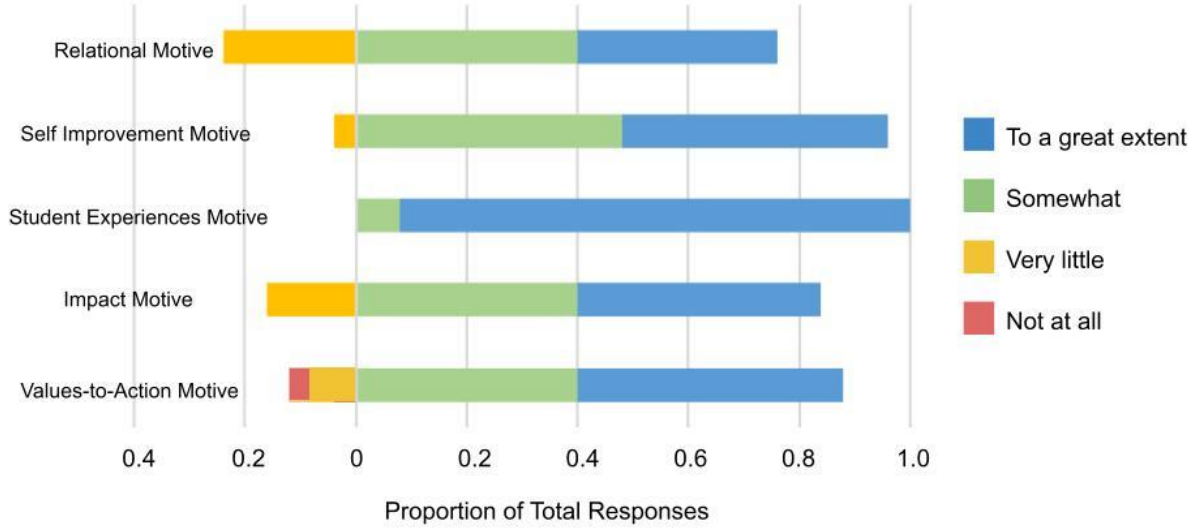


Figure 9. A stacked bar chart depicting the extent to which participants identified with each of the five motive themes. Responses are aligned between the responses of "Very Little" and "Somewhat."

Considering participants' written responses to the subsequent free-response opportunity yields additional verification of the resonance of the five motive themes. Of the 25 responses, 10 (40%) participants either left the opportunity to indicate other motives blank or wrote in a response such as "No other reasons in particular" (Ricardo, KU). Both blank responses or responses like Ricardo's were considered as affirming of the five motive themes as fully reflective of their own perspectives on their motives for joining the NIC. Three (12%) participants used the free response space to explicitly affirm a named motive; for example, Ethan (TU) wrote the following:

> I want to better understand what DEI in mathematics is really about and what it looks like. This is the 'self-improvement' motive…I'd really like to know how to improve access for students without just lowering expectations.

This sentiment was also present in Ethan's journal entries, and he used the space provided in this member-checking survey to explicitly name it as a *self-improvement* motive. Similarly, Senna (KU) provided an "expansion of the Student Experience" motive in which she expressed a desire

to help students "gain confidence in their skills/abilities beyond the university, and how it might relate to their future." Parker (KU) indicated that "the student experiences motive encompasses [her] primary motive for participating in the NIC." Together, responses which were left blank, indicated no additional motives, or used the space to reflect or expand on their thoughts around a particular motive encompassed a slim majority (13; 52%) of the responses.

Of the remaining 12 participants, 11 expressed motives in the free response portion which, while the participants may have felt they existed outside the categorization of the brief definitions of each motive provided to them, fit within the existing five themes when compared with the more extended definitions. This was a limitation of providing them with brief definitions as opposed to more extended ones, or providing NIC members with examples of coded data. For example, while acquiring or improving professional skills around mathematics education research does fall within the *self-improvement* theme, this dimension of the theme is not apparent from the brief definition given, and thus several participants used the free response space to elaborate on this desire. Tiersa (KU) expressed the following:

> I'm not sure if this is contained in the self-improvement motive, but I stand to learn a lot from the ACT UP research team about math education research and the scholarship of teaching and learning.

Angela (AU) also indicated that "experience with using data and feedback loops to improve student experiences" was a part of her motive for joining the NIC, and similarly, Timothy (KU) expressed that NIC participation will allow him "to improve [his] research and analytical skills." While these are professional skills that would fall under the extended definition of *self-improvement*, they were not easily attributed within any of the themes' brief descriptions.

The *self-improvement* theme was the most commonly mentioned in the space to elaborate, with six of the 11 participants mentioning a dimension of self-improvement in their elaboration. In addition to the examples on research skill improvement provided above, other dimensions mentioned included desires to assess one's own classroom practices (Jordan and Adele, TU) or "benefit from the knowledge of researchers who are engaged with the current educational literature" in undergraduate mathematics education (Jarrett, TU). The *influence* motive theme was mentioned four times each in these 11 responses. In an example of an *influence* motive in these responses, Ruby wrote:

> My other motive feels like it is more for myself. I like being a part of something bigger where I can help improve students' association with math. To have a part and say I helped and inspired other POC, to show that we have a part and can achieve more than we think.

Ruby's response encompasses both an *influence* motive and a *student experience* motive, in a way which connects to her own identity as a person of color. Other *influence* motives expressed a desire to be a part of shifting faculty perspectives (Olivia, TU), bring one's unique perspective into a decision-making space (Kiara, KU), and "be a part of the solution" to critical issues facing students (Timothy, KU).

The one response which did not fit any of the existing responses was that of Chelsea (AU). Chelsea indicated that she has "continued working with the NIC because it's made a great influence on me." This sentiment, without specification, is not clearly coded into any of the five motive themes, which may be for good reason; as Chelsea had already participated in several semesters of the AU NIC at this point, her statement reflects a sentiment which *continually* motivates her engagement, rather than one which motivated her initial decision to get involved in

the NIC. An inability to code Chelsea's statement is a consequence of Birt and colleagues' (2016) identified limitation of member checking with analyzed, synthesized data; by asking participants to complete this member check process in January 2024, I am collecting perspectives several semesters after many of them joined their local NICs, and thus I must consider the possibility that their expressed motives in this member-checking process reflect motives for *continuing*, rather than *initial*, NIC engagement.

In summary, participant responses to this member-checking process indicated that five motive themes are fairly robust in describing NIC members' reasoning for their own participation. Within the total 125 responses generated by the rating scale across all five themes, 111 (89%) of responses indicated "Somewhat" or "To a great extent", and only one participant selecting "Not at all" with regard to resonance of the five themes. A majority of participants either left the free response opportunity to discuss additional motives outside of the themes blank, indicated the motive themes did encompass their perspectives on their own motives, or used the free response space to provide more details on their resonance with a particular motive theme. Of those who offered additional motives that they felt existed outside the five themes, all but one response could be coded using the extended definitions of the existing themes. This one response appeared to reflect a motive for continuing, rather than initial, participation in the NIC, and thus its inability to be coded within the existing themes is not seen as indicative of an incomplete thematic depiction of participants' motives for joining their local NICs.

In the following section (4.3), I elaborate on what the five themes (*relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives) tell us about NIC members' participation in equity-oriented spaces through a critical

lens, and provide recommendations for learning to see beyond self-interest and engage in transformative change efforts with relevance to NIC members' expressed motives.

4.3: Discussion

A reflexive thematic analysis on journal and interview data from 30 NIC members across three institutions produced five themes which motivated their participation in an equity-oriented network improvement community (NIC): *relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives. These codes were not disjoint, but often overlapped, resulting in several double- or triple-coded excerpts. NIC members indicated the robustness and validity of these codes through a rating scale and an opportunity to elaborate on any additional motives which felt salient. Only one participant expressed a motive in their journal entry which could not be meaningfully incorporated into these five themes; this was Timothy's (KU) assertion that the stipend which accompanied NIC membership motivated his participation. These five themes would suggest that these undergraduate mathematics community members recognize engagement in equity work as a path for personal and professional growth (evidenced by *self-improvement* and *values to action* motives), see values unique to collective activity (evidenced by *relational* and *influence* motives), and seek to better student experiences (evidenced by *student experience* motives). Each of these motives can build upon other extant literature in important ways; for example, Roulston (2021) points to the critical impact of intentional community-building within academia, and the *relational* motive takes on heightened meaning as undergraduate mathematics community members recognize collaborative equity reform as a setting through which to engage in such community-building. In this section, I present a critical analysis of whose interests are centered within these motives, the ways in which the motives are expressed, and briefly discuss the

influence of individualism and collectivism, as well as a conceptualization of *personal enlightened self-interest.* Drawing on work from Idahosa and Vincent (2019), I then provide recommendations for practitioners looking to see beyond self-interest to engage in transformative change efforts.

In this discussion, I return to the initial interrogation I proposed in the introduction of this dissertation: an interrogation into whose interests are centered in the reasoning for conducting equity work. Applying such a question to these findings yields an opportunity for critical engagement with these data. I argue that these motives center the interests of two particular groups: undergraduate mathematics students, and NIC members themselves. The *student experience* motive reflects an understanding that NIC members' NIC participation will benefit students in introductory mathematics courses at that institution. The other four motives– *relational* motives, *self-improvement* motives, *influence* motives, and *values to action* motives– may consider undergraduate students as secondary beneficiaries, but principally center the interests of the NIC members themselves.

I begin with a dissection of the *student experience* motive. Centering the interests of students, these motives promoted more positive qualitative and quantitative outcomes for students enrolled in undergraduate mathematics. In some cases, these motives were expressed with relevance toward improving the experiences of a specific group of students; for example, an anonymous KU participant expressed a desire to specifically foster better mathematics learning experiences for Queer mathematicians. Other identifications of specific groups of students were more vague. For example, Jordan's (TU) statement of wanting to "support students of diverse backgrounds" in the undergraduate mathematics classroom insinuates a recognition of differential experiences in the mathematics classroom based upon background, without explicitly

naming a social identity. However, most *student experience* motives expressed by NIC members adhered to identity-neutral language in their motives for NIC participation, in which they express a desire to improve undergraduate mathematics experiences for *all* students, treating them as a monolithic group. For example, Parker (KU) shares that she "believe[s] there are things we can do as mathematicians and educators to improve the experience students have with math and promote a greater affinity for the subject." This motive does not point toward consideration of DEI issues within those experiences, but rather centers on a desire to improve mathematical experiences for all students involved in introductory mathematics courses at KU. While improving mathematics education *for all* students is a "worthy philosophical approach to mathematics education" (p. 7), Martin (2003) recognizes the history of this rhetoric–and its current use in equity reform–as erasing the "social and structural realities faced by marginalized students outside of school and the ways that mathematical opportunities are situated in those larger realities" (p. 7). Seeking to transform experiences for all students at a university is aspirational, but one which similarly erases the differential experiences in which reform for equity should be rooted.

Prior to NIC participation (and thus prior to the journal entry and interview data upon which this investigation is built), NIC members were informed of the equity-oriented nature of the ACT UP Math project. It is interesting then to observe that so many *student experience* motives focused on improving experiences for all students, rather than focusing on creating more equitable outcomes or experiences through a recognition of the marginalization of students with particular identities in undergraduate mathematics. I view this as a way in which the work of McNiell and colleagues (2022) manifests in expressed motives for equity reform among undergraduate mathematics program community members. McNiell and colleagues' work

recognized the prevalence of identity-neutral discourse among mathematics faculty members, in which instructional events are deemed race- and gender-neutral. If instructional events are dominantly conceptualized as spaces in which identity does not matter, then creating instructional reform which benefits marginalized populations can be easily equated with creating instructional reform which benefits all students. Since NIC members had an awareness that the ACT UP Math project was meant to be equity-oriented, these data would indicate that many NIC members conceptualized equity work as something which should explicitly benefit *all* students. While arguably reform for equity does add value for all participants in a learning environment, to equate improving experiences equitably and improving experiences universally presents the risk of continued marginalization. Leyva and colleagues (2022) describe instructional practices which support all students as "necessary yet insufficient" for meaningfully addressing the racialized and gendered nature of learning opportunities in the undergraduate mathematics classroom, examining the ways in which students with marginalized identities continue to experience identity-based marginalization within the context of supports designed for all students.

This would insinuate that reform constructed from a "for all" perspective might indeed serve to uplift the experiences of all students in that introductory mathematics program, but that aims of equity rooted in differential experiences will be lost and marginalization may be maintained within reform. Because motives act as guiding factors for an individuals' participation in an activity (Miettinen, 2005), an abundance of "for all" motives may contribute to making this kind of rhetoric particularly prevalent as the NIC engages in reform. Future work theorizing on links between motives and associated reform efforts for equity in higher education spaces will do well to keep in mind whether such rhetoric is transferable to "for all"-focused actions as these NIC members do act on their motives. The ACT UP Math project has already

started the process of assessing how identity neutrality has worked its way into the reform efforts of all three institutions (see Hagman et al., 2024); recognizing the "for all" rhetoric of community members' motives supports these ongoing analyses. Chapter 6 will provide a preliminary consideration of how identity neutrality manifested in the case of the KU NIC.

Apart from *student experience* motives, NIC members expressed motives which principally center their own social, intellectual, and professional satisfaction interests. The other four motives (*relational, self-improvement, influence,* and *values to action* motives) align with Bouwma-Gearhart's (2011) articulation of the *needs* of STEM faculty which they aim to satisfy through participation in professional development: a need for social relations (exemplified through *relational* motives), a need for pedagogical (and in this case, equity-oriented) competence (exemplified through *self-improvement* motives), and a need to feel comfortable in autonomy. The latter is more nuanced, but I argue that both the *influence* and *values to action* motives are oriented toward this need. Bouwma-Gearhart articulates this need as feeling comfortable with the responsibility that academic positions hold by nature of their relative autonomy; as such, opportunities to enacting personally held values, or leverage one's perspective to make changes to practice and policy, are relevant dimensions of satisfying such a need. In this way, these motives–notably of students, administrators, and faculty alike–connect to satisfying personal needs of these individuals. Maintaining and strengthening relationships, growing in one's own knowledge, having influence on practice and policy, and enacting one's own values are all in service of different dimensions of self-interest.

Notably, these motives which center self-interests *can* result in positive change for other members of the undergraduate mathematics education community. For example, an instructor who asserts they are motivated to join the NIC because they'd like to learn more about inclusive

practices may do so with the intention of constructing more inclusive classroom environments. The construction of such learning environments can then serve to benefit students in undergraduate mathematics programs. However, the motive itself–to learn more about inclusive teaching practices–is one which centers the instructor and their own attainment of additional knowledge. This was a distinction between excerpts which were double-coded with student experience and those which were not. To be double-coded, the excerpt had to explicitly mention a desire to have a positive impact on students' experiences. Consider the six excerpts provided in Table 6 as examples of this distinction in the coding schema. The first column contains excerpts exclusively coded as *student experience*, and the third column contains excerpts exclusively coded as other motive themes. The central column represents cases in which an excerpt was double coded with another motive theme *and* as a *student experience* motive. Note that the excerpts in the third column, which were not double-coded, could still result in a positive impact on student experience, but the interest centered within them is of the NIC member themselves.

Table 6. Examples of distinctions between excerpts double-coded with student experience motives and those without double-coding.

Single-Coded as *Student Experience*	**Double-Coded with *Student Experience***	**Single-Coded but Could Have a Secondary Impact on Students' Experiences**
(Student Experience) "I'd love to help students start to like math, there are so many who feel they can't do it and therefore hate math. Math can be such a beautiful, fun thing, and I have seen students go from hate to like and even love." (Chelsea, AU)	*(Student Experience and Self-Improvement)* "Just stopping regularly to think critically about issues of diversity, equity, and inclusion [benefits] me and my students, regardless of whether I've, you know, come up with some action item." (Garrett, TU)	*(Self-Improvement) "*I want to affirm the practices I already have in my classroom, learn about other ways to be inclusive in my teaching, and actively reflect on how math is diverse and how diverse today's mathematicians are (when I typically think of it an old, white man's subject)." (Anonymous, TU)

(Student Experience) "Math is never going to be everyone's favorite subject, but I believe there are things we can do as mathematicians and educators to improve the experience students have with math and promote a greater affinity for the subject." (Parker, KU)	*(Student Experience and Influence) "*I want to bring [my] perspective to contribute to better math instruction in the future for all young mathematicians, but in particular for Queer mathematicians." (Anonymous, KU)	*(Influence)* "My hope is that this project helps us see things that we cannot currently see. Our department is doing a lot of work to improve, but I often wonder about the things we are not doing because we are not seeing the problem yet. Once we can see the problems we can start trying to address them." (Anonymous, AU)

As mentioned earlier in this section, *relational, self-improvement, influence,* and *values to action* motives indicate an awareness of the ways in which engaging in the ACT UP Math project (a collaborative, equity-oriented reform effort) could benefit oneself through enhancing relationships, improving knowledge and practice, fostering a broader sphere of influence, and providing one with an opportunity to enact personally held values. I assert that this awareness is a positive; drawing on Hardré's (2012) finding that motives based in personal experiences and values held greater sway over faculty members' behaviors than external incentives, the ability of undergraduate mathematics community members to position working toward equity as something which can benefit *them* is encouraging for calling in additional members of the community to engage in reform. The relatively even distribution of this recognition among students, faculty, and administrators across all three institutions indicates that this knowledge of the benefits of working toward equity in collaboration with others is widely known, at least amongst those choosing to take part in such efforts.

However, action rooted in self-interest warrants critical thought. To begin dissecting self-interest in the context of equity-oriented reform, I borrow from the Critical Race Theory (CRT) concept of *interest convergence*. As one of the core tenets of CRT, interest convergence holds that progress toward racial equity is only attained when the actions constituting such progress

align with economic benefits for upper-class white people and psychosocial benefits for working-class white people (Bell, 1980; Ladson-Billings & Tate, 1995). In a historical account of reform in mathematics education, Berry (2018) writes

> Positioning marginalized people's increased participation in mathematics to meet interests that may not include their own commodifies them by affixing a market value to their collective potential labor and intellectual property. (p. 11)

Several scholars have studied interest convergence in the context of STEM reform, highlighting the commodification of students of color in the service of dominant, White interests (e.g. Basile & Lopez, 2015; Berry, 2015; Ellis, 2008; Martin, 2003). When considering NIC members' motives which center self-interest, we cannot discount a parallel commodification of students' experiences in the service of others' needs. The intentional ambiguity of target population to benefit from equity reform indicated by the ACT UP Math project makes it difficult to ascertain *whose* learning experiences are being commodified, but it is fairly evident within these motives that the benefits associated with working toward bettering those experiences are also serving the NIC member themself. As is the case in interest convergence, this does not necessarily mean that benefits cannot be realized by the students who are the subject of such reform, but that the reform was only enabled through the realization of benefits for folks who hold power within the undergraduate mathematics educational system, and thus serves to limit opportunities for transformative change.

We can also understand this phenomenon of self-interest in motive through a lens of individualism. Individualism as an ideology is structurally ingrained into Western educational environments (see Barwell et al., 2024; López et al., 2019; James, 2019), and asserts that "the ties between individuals are loose and hence everyone is expected to look after him or herself"

(Boone et al., 2007, p. 212). It is most often contrasted with collectivism, which focuses on promoting relationships and enhancing shared space. Notably, *relational* motives then are in service of collectivist aims. However, the majority of *self-improvement* and *influence* motives expressed for NIC participation take the stance of improving the educational environment with attention paid to how to take care of oneself within that environment. Radford (2012) frames the logic of individualism as one in which "I am willing to transact if, at the end, *my* wealth (here knowledge) increases" (p. 109); we see this distinction in the examples within Table 7. Notably, an individualist orientation does not exclude a collectivist orientation, but motives could exist on a continuum in which one ideology over the other might be emphasized (Barwell et al., 2024). It is beyond the scope of this analysis to dissect how an individualist or collectivist motive would impact participation, but as this work conceptualizes motives as guiding forces for activity engagement, it is fair to assume this distinction may impact how members participate in the NIC. One preliminary indicator of this connection comes from the TU NIC, whose members expressed a particularly large proportion of individualistic *self-improvement* motives. On October 23, 2023, a fellow ACT UP Math research team member shared with me a reflection from one of the TU NIC members, in which they expressed that the TU NIC was "feeling like professional development" although he wanted it to feel like more of a collective endeavor toward change. While the TU NIC was meeting regularly, TU NIC members were using those meetings to improve their own practices in a way reflective of individualistic values, reducing opportunities for collective action and growth within the TU NIC. This points to an initial indication that understanding these motives through an individualist/collectivist ideological framing may also provide insight into why certain tensions, such as the one expressed by the TU NIC leader above,

manifest in collective efforts, and how these individualistic orientations may detract from the collectivist goals.

Table 7. Examples of individualist versus collectivist motives expressed by NIC members.

Individualist	**Collectivist**
I feel that a major revision in [higher education] is imminent, and it will be coming sooner than expected. Personally, I would like to be prepared for it and one way in doing that is to be engaged in projects that address some of its current challenges. (Sabrina, TU, *self-improvement* motive)	I would like to be a part of a community! Especially coming off the pandemic, I feel a distance from my colleagues. I would like to take a more proactive approach towards working with colleagues and building connections and relationships. (Anonymous, TU, *relational* motive)

Informed by these reflections and critiques, I conceptualize motives which center the self while working toward equity-oriented reform as a form of *personal enlightened self-interest.* Secada (1989) argues that *enlightened self-interest* occurs when DEI-focused reform is conducted with the primary reasoning that it will benefit the school, majority students, or the STEM industry. Thus, the reasoning for reform is self-interested in that its impetus supports the dominance of a particular entity (i.e. US economic interests or the STEM industry) through the "enlightened" cause of enhancing DEI. Secada asserts that enlightened self-interest and mathematics education ought not overlap, problematizing reform efforts which consider the learning needs and interests of marginalized students and communities as commodities in service to broader entities, such as institutions or STEM industries. Enlightened self-interest has been investigated on the STEM policy level, yielding important critical analyses of ways in which the interests of marginalized folks are decentered in favor of serving powerful systems (i.e. Basile & Lopez, 2015; Secada, 1989). Given the nature of these motives as indicating work toward equity reform insomuch as it aligns with the personal interests of the NIC members themselves, I

consider these as indicative of forms enlightened self-interest might take at the personal level of undergraduate mathematics community members' motives for working toward equity.

Conceptualizing enlightened self-interest on a personal level troubles Secada's (1989) claim that enlightened self-interest and mathematics education should be kept distinct; can there be a productive path forward when the motives of folks working toward equity reform embody personal enlightened self-interest? Beck (1990) would appear to argue *yes,* writing that "a degree of concern for well-being of others as well as oneself seems to be a part of human nature, so that to reasons of enlightened self-interest may be added innate altruism" (p. 22) when discussing the need to work toward equality within K-12 schooling. Howard (2011) articulates that self-interest can be *mutual*; that is, self-interested perspectives *can* "[disrupt] the notion that doing what benefits the self must come at a cost to others" (p. 11). Their findings on the self-interested motives of affluent undergraduate students for engaging in social justice work assert that self-interest can be expressed and acted upon in conjunction with the interests of others. This mirrors my observation that many of these self-interested motives could serve to benefit marginalized students within introductory mathematics courses, even if that was not the central interest served within the expressed motive. Simultaneously, Howard observes that self-interested motives often preserve dimensions of privilege and rationalize the maintenance of power. If self-interest and equity reform are to coexist, recognizing and seeing beyond self-interest and consciously centering the interests of marginalized individuals and communities is fundamental in constructing transformative change (Idahosa & Vincent, 2019). Self-interest motives such as these four (*relational, self-improvement, influence,* and *values to action*) may play a productive role in leading folks to initial engagement with equity reform. However, it becomes particularly crucial that they grow beyond motives which center their own interests as they learn more about

what equity looks like in higher education mathematics spaces and participate in reforming those spaces. Motives are fluid constructs, and can shift depending upon context (Kezar, 2010) and activity (Miettinen, 2005). While self-interest may never be completely removed from an individuals' reasoning for participating in equity-oriented reform, understanding one's own self-interest and working to decenter it may be a psychological process that could ultimately enhance the effectiveness of equity-oriented reform endeavors.

I have dissected some of my own self-interests in the context of this work and feel on a personal level that my motives for engagement with equity work (in my case, scholarly work aimed at promoting the adoption of equitable practices and reform in undergraduate mathematics) will always contain some degree of self-interest. This was valuable reflection, *and* I recognize it was not necessarily actionable reflection; while an awareness of self-interest in equity work might be a first step toward decentering my own interests, it is difficult for me to understand the psychological processes by which I am decentering my own interests (if I am, which is my aim). This is where I draw on the work of Idahosa and Vincent (2019) in South African universities to provide recommendations for myself and for others: as we recognize self-interest, we can work to see beyond it and support more critical, transformative change toward equity in higher education.

With the knowledge that self-interest can limit opportunities for critical engagement, Idahosa and Vincent (2019) detail ways in which an individual can become *critically engaged* through reflexive practices. They explicitly define critical engagement as an ability to see beyond one's own self-interest from a vantage point of comfort within a system. In this context, both NIC members and I occupy (relative and differential) positions of comfort within academic systems. Seeking to critically change those systems, then, requires seeing beyond our own self-

interest. Drawing on the perspectives and experiences of ten academics identified by their communities as transformative equity-oriented leaders, Idahosa and Vincent (2019) provide four psychosocial practices, detailed below, associated with critical engagement.

- *Disrupting comfort:* opening oneself up to uncomfortable situations through understanding one's positioning in context. For example, two of the white academics interviewed by Idahosa and Vincent express that they often need to step back and give up authority in order to disrupt the comfort in power afforded to them by their whiteness.
- *Apprehending the natural as strange:* maintaining an awareness of what might be taken for granted as 'normal', and disrupting that normalcy. This included considering and listening to diverse viewpoints about experiences that may have been previously considered "normal," and aligns with other literature on questioning normative discourses in education (such as Gutiérrez's (2013) notion of *transparency*).
- *Imagining a different order of things:* continually envisioning different realities, and imagining oneself as capable of working toward achieving that reality. In Idahosa and Vincent's work, they share two examples of academics who recognize themselves as victims of oppression, but also recognize themselves as capable of imagining a different world and recognize their own abilities (alongside the abilities of their collaborators and communities) to make transformative change.
- *Reflexivity:* the process of regularly "standing in relation to oneself" (p. 789) through self-examination and self-questioning. Idahosa and Vincent provide an example of an academic who expressed critical consideration of how his actions have many times worked to mentor students through the existing system of higher education, rather than

actively disrupting that system; they view this as indicative of critical awareness which enables a reformulation of interest.

They note that these processes, enveloped into the construct of critical engagement, "enable the individual to reformulate her interest by reflection on her position vis-á-vis her social context" (p. 790), and that such reformulation opens up opportunities for greater critical change. As such, these reflexive practices may prove useful as we recognize self-interest in our own equity-oriented projects and work to see beyond such self-interest.

In summary, this analysis identified five motive themes which built upon previous literature on motives for activism and professional development. These themes proved robust when presented to the NIC members themselves, solidifying the five themes: *relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives. The themes indicate that these undergraduate mathematics community members view engaging in collective equity work as an opportunity for social, personal, and professional growth, as well as a way to influence department practice and policy and improve the experiences of students at their institution. Some participants connected these motives to personal experiences, the experiences of others, or education around equity issues, as indicated in Tuters (2017), and the majority of motives reflected an individualist orientation despite the intended collective nature of NIC activity. A critical lens on the occurrence of these themes yields an initial understanding of identity-neutral discourse in the motives of undergraduate mathematics community members for participation in equity-oriented reform, and an awareness of the ways in which motives can center the self. Drawing on Idahosa and Vincent's (2019) work, I view this work as indicative of a need to dissect and decenter such self-interest as

mathematics education community members, including myself, continue to work toward more equitable systems and structures within higher education.

CHAPTER 5: INVESTIGATING COLLECTIVE OBJECT GENERATION

In this chapter, I detail the second investigation of this dissertation, in which I sought understanding of how NIC members developed a shared object for their work. Using cultural historical activity theory (CHAT) as a conceptual framework, I detail the *rules, communities, artifacts,* dimensions of *subject,* and *divisions of labor* which proved salient as the KU NIC constructed their shared object: interrogating rigor and volume of work within their introductory mathematics coursework. This analysis is performed in service of answering the research question: *What are the salient features which mediate mathematics instructors' and students' collective generation of a shared object for equity-oriented reform?*

5.1 Methods

In order to consider how the Fall 2023 KU NIC generated a collective object for their NIC's work, I relied on a mini-ethnographic case study design (Fusch et al., 2017). KU was chosen as the focus for this case study because of the knowledge I, as the ethnographer, hold from both prior involvement in data analysis at KU (see Apkarian et al., accepted; McGrane et al., 2021; Street et al., 2021; Tremaine et al., 2022; Voigt et al., 2022) and my current involvement as an observer and often participant in the local KU NIC meetings–a role which I have now occupied for over a year. This involvement in KU's NIC provided me with cultural and historical knowledge of KU as an institution, and the KU mathematics department as a functioning body within that institution. This knowledge contextualizes my interpretations of the resources with which NIC members build a shared object. Below, I provide a more in-depth description of the activity of the local KU NIC and detail my mini-ethnographic case study process with relevance to a CHAT framing.

5.1.1: Kappa University NIC

As mentioned in Chapter 3, Kappa University (KU) is a private, not-for-profit, highly selective doctoral-degree-granting institution that is research-intensive (R1) in the southern United States. Introductory mathematics courses are taught in large lecture settings by faculty members, who are supported by undergraduate or graduate Learning Assistants. According to institutionally documented demographics, KU's undergraduate students are 48% white, 21% Asian, 10% Black or African American, 8% Hispanic and/or Latin*, and 3% multi-racial. Without an institutionalized option for non-binary genders, 50.5% of the undergraduate students identify as women, and 49.5% identify as men. KU previously participated in the *Progress through Calculus* project (*PtC;* NSF DUE #1430540) which provided them with substantial local data about student experiences in introductory mathematics, disaggregated by demographic markers. The data available to the KU NIC included student responses to the SPIPS-M survey (Craeger et al., 2022), a KU-developed student experience survey which I will refer to as the KU Survey, and focus group data collected by the Spring 2023 KU NIC.

In addition, I highlight that KU is located within a state that is actively engaged in limiting DEI efforts in higher education through state-wide legislation (Chronicle of Higher Education, 2024). Although KU is a private institution that does not directly rely on state funding, KU policies related to promoting DEI have come under media attack in recent years. The university continues explicitly posting statements of support for DEI efforts on their website and continues constructing and advertising strategic plans to address DEI within the current political climate of their state. However, this climate is not without influence on the happenings of KU. One of the KU NIC leaders indicated to us that she felt wariness with regard to explicitly naming social identities within equity work, and had experienced previous instances where

naming gender specifically was discouraged by institutional powers in favor of centering *all* students in reform. Simultaneously, NIC members tended to feel that the math department and institution was overall encouraging of DEI efforts, in addition to experiencing limited feelings of agency. For example, Senna writes the following about the intersection of her role and DEI at KU:

> I feel empowered to spend a lot of time and energy around [addressing DEI] in the courses I teach, but less so beyond that. I feel that the majority of my department (and certainly my university) are open to and encouraging of positive changes in these areas. But, especially in [the math department], I think there is a tendency toward familiarity and things that seem to be working fine.

Tiersa and Skylar share similar perspectives in their journal entries, noting that while they feel in control of their own classes, they feel uncertain of the agency they have to make broader, department-wide change. Skylar also expresses an awareness that DEI is something that the institution values, but that this valuation is not necessarily formalized; she shared in her interview that "maybe [DEI] is something the institution talks about a lot, but ultimately it's not factored into tenure at all." Timothy shares that, from his point of view as an undergraduate student, "DEI is a significant part of our entire university, along with the math department. I think that many professors and administrators are working to improve DEI at [KU]." He also notes, though, that he feels he has limited power to make change, but feels like "these team members might." As such, NIC members saw the institution and departments' support for DEI in mixed ways, recognizing that different stakeholders may place different valuations on DEI work within KU.

The KU NIC is led by two faculty members, Skylar and Tiersa, who recruited other NIC members through open-ended email surveys of interest and personalized invitations. The rest of this section will provide some additional context on KU NIC members, intra-NIC professional relationships, and the specific context of introductory mathematics at KU. The NIC members at the time of this collective goal generation began their work together in August of 2023. In order to discuss positionality while also addressing participant concerns about anonymity, the ACT UP Math research team constructed a process wherein local NIC members named identities which felt salient to their work, and a research team member wrote these identities into a written positionality statement for the NIC. I remind the reader of KU's statement, provided in the next paragraph.

The KU NIC consists of two undergraduate students (one of whom is an international student), two graduate students, and four faculty members, some of whom are in their early career. The graduate students and the faculty members are all actively involved in undergraduate mathematics instruction at KU. Most members of the NIC identify as "math people," but several recognize that they have experienced struggle throughout their mathematical journeys. All but one are math majors or hold degrees in mathematics. In addition to these practice-based identities, many members recognize explicitly that they hold "characteristics that the dominant educational system is designed to privilege, and have benefitted from these." A majority of the NIC identify as white, as women, and as United States citizens, and about half as young adults. The NIC also includes individuals who identify as transgender, as Queer, as a first generation American, or as part of a working class background.

Within these identities, there are several positional power dynamics between members that are also worth highlighting to contextualize the development of a shared object within the

NIC. Timothy, while not presently enrolled in calculus, had taken calculus under the instruction of Skylar prior to his involvement in the NIC. Skylar approached this dynamic with a lot of intentionality–in particular, prioritizing team-building and often explicitly asking Timothy to share his perspective. In conversation with the research team prior to Fall 2023, Skylar named that she wanted Timothy to feel comfortable sharing his perspective, even if it was critical of her or her instruction. In addition, Kiara and Parker had both historically worked under Senna in a course coordination system, in which they taught recitations associated with her Calculus II lecture course. At the time of this data collection, one of them was presently working with Senna in this capacity. That graduate student reflected in a journal entry that this dynamic impacted the safety they felt when sharing more critical perspectives. I also highlight that Tiersa, Skylar, Senna, and Anna (all faculty members) had a very strong rapport, developed through a prior semester of NIC involvement as well as overlapping memberships on other department or institutional committees. In their interviews, each of them indicated great comfort and trust in working with one another.

As this is a study about motives, I also find it salient to paint for the reader a more detailed picture of the individually expressed motives found in the journal entries and interviews with these KU participants. As shown in Chapter 4 (Table 4), a quantitative analysis of how often these KU NIC participants mentioned each of the five themes indicates relatively even distribution for all themes apart from the *self-improvement* motive; participants expressed 12 instances each *relational, impact,* and *values to action* motives, and 14 *student experience* motives, with six coded instances of the *self-improvement* motive. Because interview data was not collected for the four student participants in this NIC, it may be prudent to also consider what this motive landscape looks like when only considering journal entry data so as to not over-

sample from the four faculty NIC members. When considering only journal entry data, we see a slightly different picture; the *relational* and *self-improvement* motives were mentioned six times each, and the *impact* and *values to action* motives were mentioned 10 times each. *Student experience* was mentioned in journal entries a total of 12 times. This primacy of student experience was also reflected in their responses to the rating scale member check portion of Chapter 4; seven of the eight participants indicated that they identified with the *student experience* motive "to a great extent," with the *impact* and *values to action* motives being the next most resonant.

One reason why the *student experience* motive might resonate in such a meaningful way with this NIC is the reputation of KU's introductory mathematics program. Several participants–faculty and students–highlighted the negative reputation of mathematics at KU as salient to their reasoning for joining NIC, and centered this negative reputation as something they hoped to address through NIC involvement. Tiersa offered the following context in her initial journal entry:

> Students report that "KU Math" is unnecessarily hard. Anecdotally, I believe students view the introductory courses as weed out courses designed to get them to quit math/STEM if they're not "cut out" for it.

Timothy validates this from the student perspective; as someone who had recently taken mathematics at KU, he wrote the following in his initial journal entry:

> I struggled a lot in my introductory calculus course. I put in a large amount of effort towards the course and took advantage of extra support/resources but in the end, I still struggled and don't feel that my grade reflected my effort. This left me feeling dejected and I haven't taken a math course since. The main reason I joined NIC is that many of

my peers, especially those coming from public schools with fewer resources, had similar experiences and have strayed away from math at school since.

The notion of "KU Math" as its own entity that KU students respond emotionally and actionably to was prevalent throughout the NIC's work. Near the end of the Spring 2023 semester (prior to the implementation of this iteration of the NIC), Tiersa and Skylar independently collected data from KU students asking what words they associated with "KU Math"; *challenging* came up most frequently. Some consequences of this reputation mentioned by NIC members have been students choosing to take mathematics at different institutions and transferring credits (when available), discouraging peers who are coming into KU math environments, and bonding through shared dissatisfaction with KU's introductory mathematics offerings.

Prior to the start of the ACT UP Math project, KU had already been participating in reform which began directly prior to the COVID-19 pandemic, and then continued during fully remote instruction. A subset of current KU NIC members summarized their changes in a published chapter, which I choose not to cite for anonymity. In this chapter, they explain the ways in which they reformed their calculus grading systems over the past several years to include alternative modes of assessment, such as mastery grading or non-letter grades. These reforms were designed to address equity, transparency, and inclusion issues resulting from the previous block grading system. While they are still investigating the impacts of these shifts, I bring this published chapter into conversation to illustrate that several NIC members have been continuously involved in reforming introductory mathematics at KU, and are deeply invested in ensuring more positive mathematics outcomes and experiences for KU's student population.

In order to specifically detail the events leading up to the NIC meeting which this mini-ethnographic case study will center, I provide a brief summary of the two NIC meetings that

preceded it. The Fall 2023 KU NIC had its first meeting on September 15, 2023. This first meeting focused on bringing the new undergraduate and graduate student members up to speed with regard to the ACT UP Math project, including highlighting the data sources available to them for considering reform. In explaining the context of the NIC, Skylar said that "[the NIC is] a community of people, who are networked in our connections to each other, who are working to improve undergraduate programs in math through critical transformations," and thus she outlines an initial *object* (which will later be transformed) for the NIC to work toward: the improvement of undergraduate programs in math through critical transformations.

At the second NIC meeting of the semester, on October 6th, 2023, the group continued team-building by sharing joys and struggles they've had in mathematics, as well as explicitly identifying the varieties of lived expertise they each bring to the group. Led by Tiersa and Skylar, they then took a moment to re-familiarize themselves with the SPIPS-M and the KU Survey data, which they had been asked to explore as homework. After briefly mentioning a few things they noticed from the data, they discussed different levels at which change could be made (course, department, university, US education system, global education system) and asked NIC members to think about components of each of these levels that may have an impact on KU student experience. This led into a conversation about students coming in with different levels of previous mathematical resources, resulting in some disagreement about the necessity of the "rigor" of KU mathematics. This conversation was not explicitly resolved. Tiersa and Skylar then prefaced that the next meeting would be an opportunity to coalesce around a goal (object) for the NIC, and outlined the process through which that discussion would take place. They explicitly note that the goal should be one focused on "hav[ing] a positive impact on student

experience" and that it is intended to be a collective "goal for the group, something we feel we can make some headway on" (Skylar).

This then led into the next NIC meeting on October 27th, 2023, which acts as the central data source for this analysis. In this NIC meeting, they collectively came to an object for their NIC's work, refining Skylar's earlier iterated object of "improving undergraduate programs in math through critical transformations" to a more specific investigation of rigor at KU. In the next section, I detail the methods which I used to study this object generation.

5.1.2: Data Collection and Analysis

This investigation leverages a mini-ethnographic case study to understand the development of a collective object within the KU NIC through a CHAT lens. A mini-ethnographic case study embodies the exploratory functions and processes of ethnography in a time-bound and space-bound setting (Fusch et al., 2017). While ethnography traditionally focuses on exploring cultural interactions and meanings in a broad way, a mini-ethnography "is used when a field under investigation focuses on a specific or a narrow area of inquiry" (White, 2009). In this case, beginning the ethnography with the intent of exploring collective goal generation provided a focus in inquiry that moved beyond traditional ethnographic practice and toward the idea of mini-ethnography. Mini-ethnography further has a rich history in critical studies, enabling impactful findings within shorter timelines which center specific lines of critical inquiry (see, for example, Diaz et al., 2001; White, 2009).

Postholm (2015) assert micro-ethnography (a term often used interchangeably with mini-ethnography; see Bayeck, 2023) as a useful methodology aligned with the aims of CHAT due to its ability to answer questions that interweave culture with specific aims and foci. While I cannot be sure that Postholm uses micro-ethnography in the same way that Fusch et al. (2017) defines

mini-ethnography, Postholm focuses on the compatibility of focused inquiry considering discursive practice with a CHAT lens; as both of these features hold true for a mini-ethnography, I consider this methodology as compatible with Postholm's argument for methodologies appropriate to use within CHAT framings.

Conceptualizing this work as a mini-ethnographic *case study* relies on the fact that I center one university in particular: KU. A focus on few participants, rather than on all participants across the three ACT UP Math institutions (as was the case in Investigation 1), as well as the narrowing of focus to several weeks of NIC activity to contextualize a singular conversation, constitutes the *case study* nature of this mini-ethnography (Bayeck, 2023). CHAT scholars assert the importance of dialogue in the development of a shared, collective object (Postholm, 2015), and thus I center this work around the dialogue of the NIC members in this October 27th NIC meeting. Because a CHAT lens necessitates focus on the history and culture of the activity in question, I chose to center this analysis on KU, as opposed to AU or TU, as the case study site because of my own familiarity with reform at the institution through prior grant involvement and data analysis focused on KU. In addition, my current position as a graduate research assistant with the ACT UP Math grant focuses on supporting KU specifically. This case study is exploratory; the current scope of the work will not include any comparison to either of the other two institutions involved in ACT UP Math, although this could be an interesting avenue for future work.

Within a mini-ethnographic case study, Fusch et al. (2017) highlight the importance of data triangulation. In this study, I leverage other sources of data (journal entries, interviews, field notes) to consider and contextualize my claims about the CHAT elements that proved salient for the KU NIC's development of a collective object; the use of these forms of data to triangulate

fieldwork is considered common practice (Fusch et al., 2017). However, this triangulation is limited in that I do not, within the scope of this dissertation, perform any *methodological* triangulation to affirm the importance of the elements I highlight. While I will consider participants' reflections on this collective object itself in Section 5.3, this investigation does not benefit from the additional validity which could have been attained through inspecting this object development through multiple methods. Only the mini-ethnographic case study analysis within a CHAT framing is explored.

This mini-ethnographic case study centers a particular audiovisual recording of the third KU NIC meeting of the Fall 2023 semester, which took place on October 27th, 2023. Audiovisual recordings are the most common data form for which mini-ethnography centers, as they enable a focus on a particular concept which takes into account both verbal and non-verbal communication cues (Fusch et al., 2017). The recording, which lasted an hour and a half, was made over the Zoom platform. I was virtually present for this meeting, and participants (all NIC members) were recorded from the perspective of a laptop positioned to the side of the conference table around which they were all seated. My camera was off; in other words, they could not see me during this recording. This had been standard practice for research members of the ACT UP Math team who were conducting observations of NIC meetings. Figure 10 provides a visual explanation of the process for this analysis, as will be explained in the next several paragraphs.

Following recording, I transcribed the audiovisual recording of October 27th's NIC meeting, noting both verbal and non-verbal forms of participation on the transcript. I then undertook a read-through of the transcript accompanied by extensive memo-ing with the particular intent of considering connections to other observations I'd had or contextual details of the KU NIC. For example, next to a transcribed interaction in which a graduate student

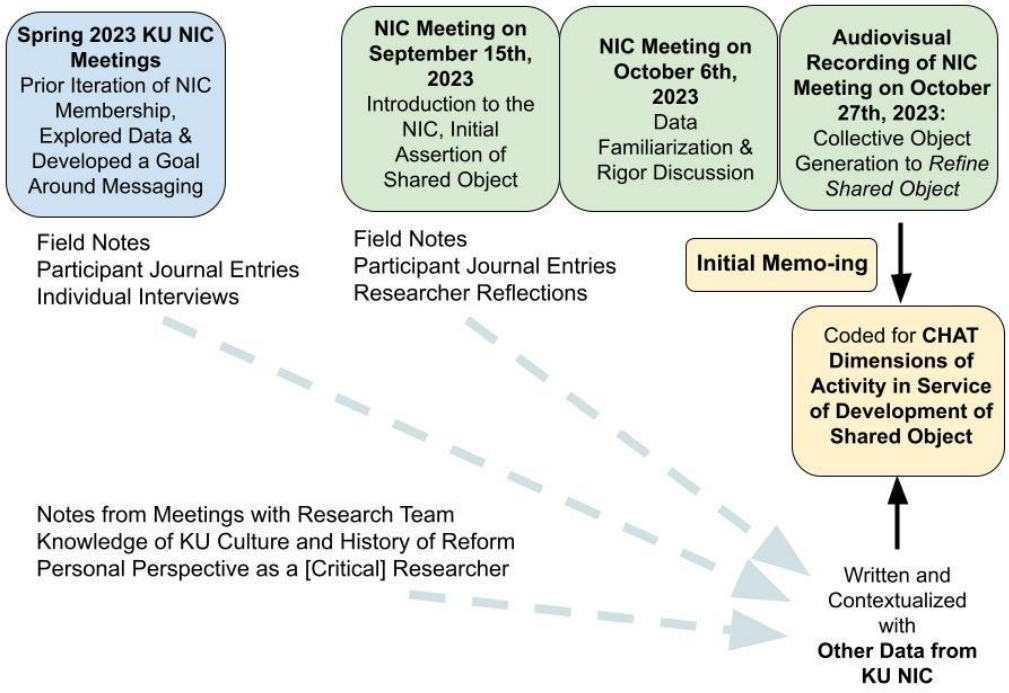


Figure 10. A dissection of the process I used to perform a mini-ethnographic case study of the KU NIC's collective object generation.

noticeably censured themselves from providing more detail on a particular critical perspective, I wrote that the interaction "feels directly related to [the graduate student's] journals about feeling uncomfortable sharing more 'radical' notions when the coordinator they work under is in the room." These kinds of memos enabled an initial understanding of the contexts upon which NIC members were drawing from within these conversations. Some of these memos were more descriptive in nature; for example, Parker begins a dialogue about a 'teacher brain' versus a 'student brain' when considering mathematical course content, and I made note of where this rhetoric began. Having also at this point familiarized myself with CHAT as a framing, I made note of instances in which a clear CHAT-based concept (artifact, subject, rule, community, or division of labor) was evident.

The second read-through of the transcript was then more explicitly focused on identifying and naming instances in which components of CHAT were invoked in service of the

development and refinement of a shared collective object for the NIC as an activity. For example, the same interaction I highlighted in the previous paragraph as being related to a graduate student's journal entries was coded as "Division of Labor: power dynamics within the NIC" with particular relevance to the ways in which the graduate student's voice was silenced, contextualized by the knowledge from their journal reflections that they didn't feel fully safe expressing their perspectives because of the presence of a supervisor within the NIC. Two additional examples of the distinction between the first and second phases of memo-ing are provided in Table 8.

Table 8. Examples of Phase 1 and Phase 2 of memos written from the meeting transcript.

Transcript Excerpt	**Phase 1 Memo (Context)**	**Phase 2 Memo (CHAT Concepts)**
00:23:08 **Senna:** And I tell them– **Skylar:** But you should do [homework that isn't graded or collected], I say it's expected but– **Senna:** Like, I know if you do it, and I think, you know if you do it, and you need to have that conversation with yourself after the first exam, and there's always people that are like, oh, you're right, I didn't– **Skylar:** And I don't require it, so this sort of incentivizing participation versus giving credit for various things I think is an interesting question too.	*Both riffing off of their experiences as instructors of these intro courses and discussing current course structure… the credit component and considering what is expected versus what is actually given credit. Skylar expressed expectations that students are taking advantage of the myriad of resources available to them, but these aren't incentivized.*	**Artifact:** Current Course Structure (credit for exams vs. credit for participation) **Subject:** Skylar personal curiosity around what is incentivized
00:23:48 *[Anna asks Kiara to articulate a goal from a thought she shared about rigor]* **Kiara:** Um, I guess the goal I would think, is to interrogate	*Kiara's emphasis in journals on the data-driven components of ACT UP Math feel salient here; she wants to know if we have data (not sure if she means SPIPS or another data source) around this idea; it wasn't*	**Artifact:** Conceptualization of Rigor **Community:** Folks involved in Extended

how much work we expect of students, and then ask what is credit-based, what's not credit-based, and then how do students respond to that. Do we have data that says one way or the other. I know this is something that [non-NIC professor] is thinking a lot about right now in the context of [Extended Calculus] specifically.	*evident in their data exploration from last time that this is for sure something the data has. Connecting it to [Extended Calculus]- Skylar was just making connections to [Extended Calculus], definitely a community external to the NIC that's having some sway over what they're thinking is doable/interesting.*	Calculus (also within department)

With this second phase complete, I constructed a model for the NIC's development of a shared object, relying on Engeström's (1987) model of second-generation CHAT, to provide an overview of the artifacts, subjects, rules, communities, and divisions of labor which impacted the shared object that they landed on at the end of this conversation. This model is presented in Section 5.2. The combination of these two memo-ing structures formed the foundation for my written presentation of the results of this mini-ethnographic case study. In presenting the outcomes of this analysis, I stratify the data into CHAT constructs (i.e., a section on *rules,* followed by a section on *communities*, followed by a section on *artifacts*, etc.). This style of presentation accentuates the critique often leveled at Engeström's (1987) model: that it provides a false impression that the dimensions of CHAT are disjoint (Toomler, 2008, in Com-Leng, 2022). Each section, therefore, contains elements of other sections; for example, in describing the *artifact* of the rank-choice voting system that the NIC leverages at the end of the meeting to decide which of their refined objects to pursue, I will necessarily need to consider the *rule* of "Be Democratic," which informed the NIC leaders' development of such a process.

I identify the writing of the Results section (Section 5.2) as a further generative process with regard to the analysis itself. In writing about what was observed as contributing to the development and refinement of the NIC's object through a CHAT lens, I was able to do a deeper

dive into the data sources referenced in Phase 1 of my memo-ing. In order to contextualize the discursive moves made by NIC members with regard to developing their shared object, I pull from data from participants' journal entries, individual interviews, and field notes taken by myself and other members of the research team both during this October 27th NIC meeting and other KU NIC meetings, and notes taken from meetings between the KU leaders (Skylar and Tiersa) and the subset of the ACT UP Math research team which works on supporting KU specifically. This multimodality of data is an important component of ethnographic approaches, and extends to mini-ethnographic case studies (Fusch et al., 2017). As is recommended in a mini-ethnographic case study specifically (Fusch et al., 2017), I engaged in direct observation, the writing of field notes, and my own reflexive journal following the meeting. This diversity of data sources, alongside other participant-centered sources like journal entries and individual interviews, are used to contextualize each of the CHAT components I detail in the following section.

5.2: Results

In this section, I will detail the results from the mini-ethnographic case study analysis through which I sought to tell a story of how the KU NIC generated a collective object, informed by the dimensions of CHAT and contextualized using field notes, journal entries, and interviews from KU. To provide an overview, I present Figure 11 as a summary of all the documented components that informed KU's development of their collective object. I will detail many of these components in stratified sections below. Each header represents a different dimension of CHAT framing: *rules, community, artifacts, subjects,* and *divisions of labor*, all in service of the development of their ultimately agreed-upon shared object: "Interrogate volume and rigor of work we expect of students. What is credit-based or not? And how are we communicating that to

students and the department? How do students respond to changes?" While the presentation of these results as distinct sections may give the impression that each dimension is disjoint, the dimensions of CHAT are necessarily interrelated, and I will frequently discuss other dimensions in each section as I consider how the shared object was developed.

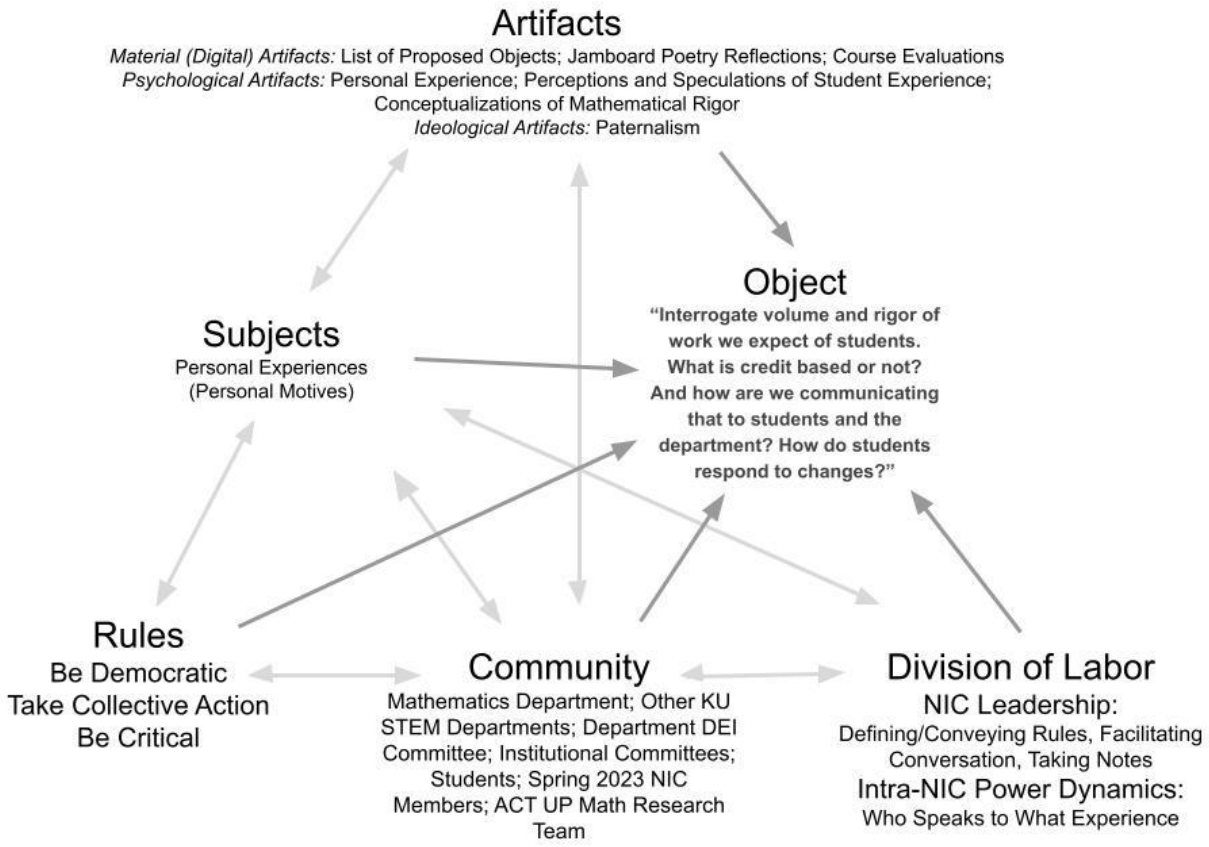


Figure 11. An overview of salient features of CHAT model toward the KU NIC's development of their shared object.

5.2.1: Rules

Throughout the October 27th NIC meeting, KU NIC members invoked three rules to guide their development of a shared object: *be critical, be action-oriented,* and *be democratic*. I will first discuss the latter rule, *be democratic,* as it foundationally shaped the structure of the October 27th NIC meeting. Being democratic within the NIC meetings was not an explicitly

developed rule, and each of the three local NICs involved in the ACT UP Math project created their own leadership structure and NIC leaders took on various leadership roles and styles throughout the enaction of the project. For Tiersa and Skylar, however, being democratic and ensuring that their ideas were not positioned as greater than any other NIC members' ideas was particularly important, as was structuring the NIC to enable equitable decision-making. Although she notes this didn't always happen in practice, Skylar shared in her interview that "we [she and Tiersa] tried to make sure everyone had an equal voice in decision-making" and felt that "decisions on [NIC] direction were–we attempted to make them in a democratic fashion" through anonymous polls and frequent invitations to share feedback. This also translated into her self-awareness of ensuring more equitable vocal participation in the NIC meetings. In the October 27th meeting, this desire for democratic decision-making manifested in two *artifacts*: the list of anonymously proposed objects as a central artifact for engagement, and the rank-choice voting algorithm ultimately used to determine the NIC's shared object.

Prior to the meeting on October 27th, all eight NIC members were invited to anonymously submit their proposed goals/objects for the whole NIC. This was assigned at the previous NIC meeting, at which Skylar indicated that she and Tiersa would send out a one-question survey in which each member could anonymously list three goals, and that these goals would then be voted on as a group. Anna clarified with Skylar that these goals were intended to be *shared goals for the entire NIC*, hence their positioning in this work as proposed objects for NIC activity. Because not all NIC members submitted three goals, this resulted in a list of sixteen proposed objects for NIC activity, provided in Table 9. The anonymous submissions were then read and informally grouped by Tiersa based on her own perceptions of theme, though NIC members were explicitly invited to disagree with her organization. The anonymous submission

of these goals aligned with Tiersa and Skylar's aims for NIC activity to be democratic. Because they were anonymously submitted, they were most often referred to by NIC members using their number on the list; I will use the format "#XX" to refer to these proposed objects.

Table 9. Anonymously proposed objects for the NIC.

#1	Reconsider the curriculum goals for intro calculus courses to preserve a rigorous curriculum and challenge students without disheartening them.
#2	Work the ideas of 'rigor' and 'challenge' to make the challenging parts of our introductory courses also rewarding.
#3	Interrogate the meaning of 'rigor' in KU calculus.
#4	Improve the drop in average student confidence in their math abilities after an introductory course.
#5	Work to improve the student mentality about the math department through open communication and clear adjustments based on student feedback.
#6	Find a way to clearly communicate the goals of the department to students to improve buy-in and reduce animosity/frustration.
#7	Create ways to more quickly identify students who need extra assistance. A lot of resources are provided for the students, but often those who need them are not being proactive in seeking them out.
#8	Create a sustainable, "high-touch" model in which students in introductory courses can build relationships with course staff.
#9	Highlight "non-traditional" pathways through the major, including those taken by students with a myriad of interests.
#10	Make incoming students feel more comfortable when taking intro classes, as opposed to feeling pressured into taking higher-level classes right off the bat.
#11	See if we can change the organization/crediting for intro math courses to incentivize participation (longer term goal).
#12	Gain insight into the experience of students who didn't take calculus in high school.
#13	Make intro math classes at KU more inclusive for students coming in with different backgrounds in math.
#14	Clearly identify practices in our control that we can change/stop/start to improve inclusion and a sense of belonging among currently marginalized students.

#15	Make concrete suggestions to the department for changes in calculus course structures at KU.
#16	Each semester, we each carry 1 lesson from the NIC into our personal math lives to improve whatever spaces we can.

The second way in which the rule of being democratic manifested was in the rank-choice voting algorithm used near the end of the meeting, in which NIC members were asked to rank each of four proposed objects settled on through combining and refining the proposed objects. These four combined proposed objects are captured in Table 10, and resulted from the NIC's discussion. Skylar introduced this notion of rank-choice voting to the NIC by describing it as "secret ballots…we were gonna do ranked voting, but it was gonna be secret" (00:46:58). Kiara voices support for this, noting that she is a "huge proponent of ranked choice" (00:47:23). After reiterating and doing some additional refining of each, Tiersa passed out notecards to each of the NIC members, and they ranked each of the four Table 10 objects at 00:57:48. After about a minute, they hand their notecards to Tiersa. The use of a ranked-choice voting algorithm to ultimately determine which proposed object is decided on aligns with Tiersa and Skylar's democratic aims, and served to structure the decision of a shared object for the NIC.

Table 10. Four proposed shared objects developed throughout the NIC's discussion and voted on using a ranked-choice voting schema.

A	Interrogate the volume and rigor of work we expect of students. What is credit based or not? And how are we communicating that to students and the department? How do students respond to changes?
B	Find a way to identify who may need support and connect them to extra resources; improve connection between students and the instructional team.
C	Find structural ways to make incoming students feel more comfortable when taking intro classes, as opposed to feeling pressured into taking higher-level classes right off the bat.
D	See if we can change the organization/crediting for intro math courses to incentivize participation (longer term goal).

The second rule leveraged by the NIC in their development of a shared object, *be critical,* was an explicit rule provided to the KU NIC by the research team on the onset of the ACT UP Math project. Gutiérrez's (2002; 2009) axes of equity were presented to Tiersa and Skylar multiple times prior to the Fall 2023 semester: once at a Spring 2023 ACT UP Math whole team meeting, and once at a Summer 2023 Leadership Workshop. Tiersa and Skylar, who were present for these meetings, were told explicitly that the object(s) that their NIC develops should adhere to the *critical* axis. Alongside presenting these axes, the amorphous nature of 'criticality' was also discussed, and they were encouraged to share their own thoughts on what criticality might mean with the KU NIC members. See Figure 12 for an example screenshot of a slide used in prior meetings to convey this rule of being critical in local NIC activity.

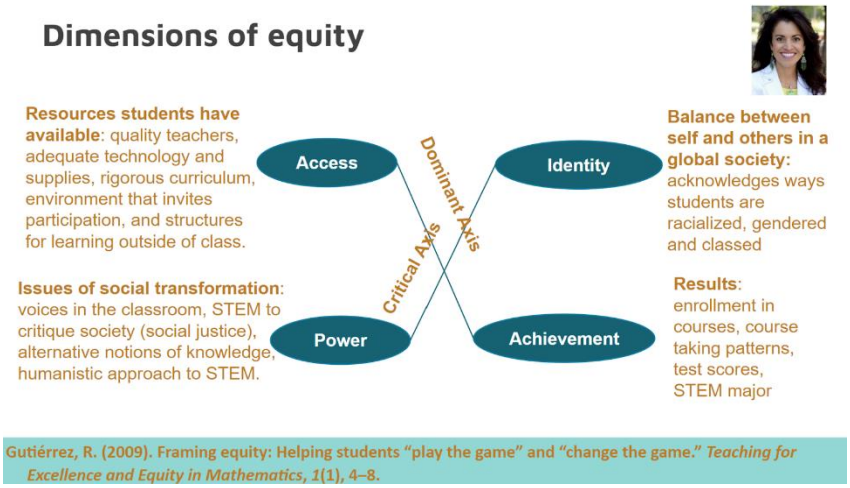


Figure 12. Example of a slide presented by members of the ACT UP Math research team to define what it means to be "critical" at early ACT UP Math meetings. This slide is from the Summer 2023 Leadership Workshop.

How Tiersa and Skylar then communicated this idea of criticality to the NIC members is documented in field notes from their initial Fall 2023 NIC meeting. They took very strongly to Gutiérrez's notion of *playing the game* versus *changing the game*, which was verbally shared during the presentation of these slides when emphasizing the contrast between working within

existing structures as a *dominant* mode of reform, versus disrupting those structures in meaningful ways to foster more *critical* modes of reform. This was evident in how Tiersa explained what it means to "be critical" to the rest of the NIC:

> You can make changes within the existing system, or you can sort of look at the system and say, 'Can I try to change the structures? Can I try to make more radical changes that are getting at, I don't know, thinking that things have to be a certain way because they've always been that way but actually don't?' And– and I'm not saying that this is necessarily good or should happen, like we should tear down the whole system. So I think part of the point of the whole project is to at least be open to that, that there are things that we maybe assume or take for granted that maybe we don't have to.

Tiersa's explanation emphasizes two dimensions of criticality: working to change structures, and investigating existing discourses as revealing possible areas of reform. While she qualifies this definition slightly, making clear that the goal is not to "tear down the whole system," she encouraged the team to think along these lines when conceptualizing "the point of the whole project." The definition of criticality as a questioning of structures was reiterated in their second NIC meeting on October 6th, in which Skylar reminded the group that being critical means "examining and interrogating systems that are in place." In research team reflections around our support for KU, we recognized that we, within the research team, have frequently emphasized that critical work is done to tackle systemic issues, and therefore addresses entrenched systems and structures. Thus, Skylar and Tiersa's conveyed perceptions of criticality are likely informed by our own emphasis of criticality as something which attends to systems and structures as opportunities for change.

It is unsurprising then that the KU NIC's rule of *be critical* could be equated with ensuring that their shared object addressed systems and structures. At several points throughout their October 27th conversation, they explicitly leveraged this rule to refine their ideas around what they wanted to work toward. I observed this in my field notes, writing that "at points, both Tiersa and Skylar reflected on the 'need to be critical'...I'm recognizing they view critical as defined through addressing the system." As one example, Skylar brought up that the Spring 2023 KU NIC came up with the idea to enhance the mathematics department's communication with the KU student body. Kiara affirmed this idea, saying, "I think that makes a lot of sense." However, Tiersa then explained the following about this previously generated idea:

> And I guess what we ran up against was like, is this–are we taking a critical approach here, in the sense that like, are we just saying leave all the structures the same, and just try to convince people? (00:26:18)

Tiersa shared their self-evaluation that this previous idea wasn't critical because it didn't make any changes to the structures of their introductory mathematics courses. This then informs how they move forward in developing their shared object. Anna began conceptualizing what a critical approach to messaging around mathematics might look like:

> You know, maybe in like forming the messaging, that maybe could inspire change so that we could say–and I say "we" by the math department– say, like, "okay, this is what we're trying to communicate; are we trying to– are we clearly communicating that through our course structures or not?" And if not, then let's–what is our–what message are we *trying* to send and are we sending it clearly through our structures. (00:26:35)

Anna's reconceptualization considers this *rule* of being critical in the context of the previously dismissed goal of addressing messaging, and proposes a way of addressing messaging that still

attends to systems and structures–the central component of how the KU NIC understands criticality.

The *rule* of being critical is referenced again when Parker noted that communication is important regardless of what the shared object is; she remarked that she doesn't "think any goal will be successful unless what we're doing and what we're trying to achieve is clearly communicated to students and to the department," but noted that "communication alone as a goal falls short…I think that does miss the critical" (00:31:19). Similarly to Tiersa's statement from earlier in the meeting, shifts in messaging are not viewed as critical, and thus are inappropriate as an isolated shared object for the NIC. After Parker's comments, Tiersa proposed writing a "monster goal" which incorporates Anna's and Parker's thoughts about the messaging dimension of a goal, framing it as the question: "How are we communicating [notions of rigor] to students?" within broader notes about a shared object related to rigor.

Parker's statement about communication falling short also begins to get at the third *rule* which shaped how the NIC developed their shared object: *take collective action*. I frame this as a rule with two parts that were interwoven in the NIC members' leveraging of this rule: there exists a need to take *action*, and that action needs to be *collective.* This rule was not explicitly proposed by the research team as a formal rule in the same way that being critical was, but framing the ACT UP Math project as an opportunity for *achieving critical transformation (ACT)* through a plan-act-reflect cycle insinuates some dimension of action as necessary for the activity of the NIC. NIC members also indicated an awareness that the NIC was intended to be a collective effort in their initial journals; for example, Kiara wrote that she was "excited by [personal skills around community organization] entering my workspace and entering a space that I feel historically hasn't been as community oriented as it could be." Kiara mentions here an

important point; collective action in mathematics departments, or in academia in general, particularly toward equity and social justice, is not common. Thus, the framing of the actions of the NIC as *collective* and done in cooperation with others may have stood out to participants, and thus been meaningfully incorporated into the implicit development of this rule.

This rule of taking collective action served to subsume certain objects into others; objects which were not explicitly action-oriented could be readily amended to more actionable objects, and therefore dismissed from consideration as a central shared object for the KU NIC. For example, in reference to #16 ("Each semester, we each carry 1 lesson from the NIC into our personal math lives to improve whatever spaces we can"), we observe the following interaction between Timothy and Senna (00:25:05):

> *Timothy:* I think #16 is also another one of those goals that we should definitely try to just do throughout the semester, but I don't know if that should be one of our main goals, but I think it's really cool–
>
> *Senna:* That will be an easy one to put in, to add the action–
>
> *Timothy:* Yeah–
>
> *Senna:* And a good idea.

Both Timothy and Senna viewed #16 as one which could be "put in" or exist alongside some main, collectively shared object. Notably, #16 was the only object which set forth an individually implemented action item; their dismissal of it as a "main goal" also insinuates some recognition that centering the NIC activity around a goal in which they are individual actors feels inappropriate. Parker's previously referenced statement about communication to students and to the department about the NIC's work as necessary but insufficient as a shared object for the NIC also positions communication as something which can be subsumed into a different, more

actionable goal. She noted that "Just communicating more, like 'hey, we're doing it, we're really doing it, we're trying' doesn't actually change." This need to "actually change" creates a contrast between an object which centers communication and an object which centers action. While communication-focused objects can be subsumed into goals which focus on action, the rule of taking collective action would indicate that the converse is not true for the KU NIC; having communication as an object without action would, as Parker expressed, "fall short."

Proposed objects were also dismissed according to this rule if they functioned more as assertions of desired outcomes than as plans for action. For example, #4 ("Improve the drop in average student confidence in their math abilities after an introductory course") was viewed as "an outcome versus a larger goal" (Anna, 00:13:43). Senna noted that she had difficulty, when drafting goals, coming up with action-centered objects as opposed to desired outcomes, saying that "I struggled when writing the goals; I realized I kept thinking of outcome but not actions" (00:14:14). Framing this as a *struggle* insinuates that Senna felt the influence of the *action* dimension of the rule of taking collective action when coming up with proposed objects for NIC activity. Senna also observed that #13 ("Make intro Math classes at KU more inclusive for students coming in with different backgrounds in Math") is similarly situated. She notes that, because this proposed object also describes an outcome rather than an action plan, the NIC should come up with a "the first step to those" if they are to consider them (#4 or #13) as the central object of their NIC activity.

Distinctions between data-gathering objects and objects for collective action were also made and used to dismiss or subsume those objects which centered data-gathering rather than change-making actions. Skylar also discussed the difference between action-oriented objects

(their target for this discussion) and data-gathering objects near the end of the meeting with the following explanation:

> My understanding of, sort of, our goals as a NIC, like what the bigger team is telling us, is we have sort of action goals, and those should be informed by data, so to help my brain I'm thinking of this as a setting for action goals, and then separately we might set some data gathering goals will support those action plans. (00:50:16)

Although focusing on action was not a formal rule set forth by the research team, Skylar very clearly attributed the need for action to the "bigger" ACT UP Math team. Further, she centralized the need to come up with an "action goal" which then serves to inform any future data gathering. Later in the meeting, Kiara also provided indication that it would be important to center action within the shared object, to avoid "data gathering for the sake of data gathering," prompting the team to first "coalesce around specific things we're thinking about changing" and then pursue additional data collection in relation to that shared object for actionable change. This comment from Kiara is affirmed by Skylar and prompted a nonverbal response from Tiersa; she actively began analyzing the NIC members' completed rank-choice voting note cards. Although she hadn't planned to necessarily come to a rank-choice conclusion in the context of this meeting, Kiara's assertion of the centrality of having a shared *actionable* object as foundational to any future data gathering efforts appears to prompt her toward analyzing the members' votes sooner rather than later.

5.2.2: Community

Throughout their development of a shared object, NIC members frequently referenced communities outside of the NIC which influenced their perceptions of what kind of object they wanted (or did not want) to share. One of the most significant ways in which this served the

development of a shared object was through the recognition that other on-campus groups may be tackling similar objects, and thus such objects may not be suitable for the NIC. This came to the forefront in discussion of proposed objects #9 ("Highlight "non-traditional" pathways through the major, including those taken by students with a myriad of interests") and #11 ("See if we can change the organization/crediting for intro math courses to incentivize participation (longer term goal)"). After a brief lull in their discussion of the list of proposed objects, Skylar introduced the following perspective:

> I felt like #9 was not in our purview right now. I think it's important, and…I will share, it's something that the department is thinking about and the DEI committee is thinking about right now. So this is something the department is thinking about. (00:15:44)

Because the department and DEI committee were also thinking about non-traditional pathways through the major, this proposed object was not seen as suitable for the NIC. This assertion resulted in Tiersa writing "not in our purview" next to #9 on the shared list of proposed objects, and it was not reconsidered in the discussion again. Later, they do discuss how non-majors and majors may have different experiences, but this is done in the context of data collection and not in service of the development of a shared object.

We see something similar–albeit with a different outcome–when the NIC addresses #11. Skylar expressed a desire to eliminate #11 from consideration because KU is presently "in the middle of this curriculum redesign" which may be dramatically changing the curriculum required of folks within the College of Arts & Sciences (where mathematics is situated). This perspective indicated that changing the amount of credits or overall organization of introductory math would be futile if another institutional organization is presently looking at making their own changes to that curriculum. Following this suggestion, Anna identified herself as someone who is presently

on the committee working toward the curriculum redesign, and leverages the artifact of her personal experience to note that they are working toward redesigning general education requirements, so it indeed may have an impact on service courses, such as introductory mathematics.

However, the NIC reconsidered Skylar's proposed elimination of #11 when **Senna** asks for clarification regarding what is meant by "crediting", noting that it could mean incentivizing participation through grades in the classroom or it could mean the credit number provided for a particular course. Notably, this disrupts the rule of being democratic as enacted through the anonymity of submitted proposed objects. **Anna** asked Tiersa and Skylar, "Would it be okay to ask whoever wrote that for clarification?" and, getting Tiersa's affirmative, Senna began to reiterate her question about credits before Timothy came into the conversation to claim the proposed object as his own. He clarified that his intention was to shift the amount of credits provided for the course. The *division of labor* component of intra-NIC power dynamics was not lost on this situation; Timothy was an undergraduate student, in a situation in which three faculty members affirmed that it would be useful for him to disrupt his own anonymity. This disruption of the democratic functioning of the NIC, centered around de-anonymizing the proposed objects, allowed for progress through Timothy's clarification of his intentions, but was also brought about through a situation in which Timothy was made vulnerable and subject to potential feelings of pressure informed by intra-NIC power dynamics.

Ultimately, with this clarification provided by Timothy, the NIC made the decision to keep this proposed object in consideration, with the acknowledgement that coordination with the committee facilitating the curricular redesign might be required. The following interaction between Tiersa and Skylar solidifies this decision:

Tiersa: So, I vote for keeping [#11]--

Skylar: Okay.

Tiersa: –because maybe our action plan is, like, lobbying the curriculum committee.

Skylar: That's a really good point! Okay! Nevermind. I just wanted to make sure people knew about the curriculum redesign. (00:21:59)

Within this finalization of the NIC's decision to keep #11 as a consideration for their shared object, Skylar reiterated her view of the importance of being aware that another on-campus group at KU may have an impact on how that shared object could be implemented.

Communities outside of the NIC were also referenced in terms of how they might perceive the NIC's shared object, which then informed whether the NIC members made conclusions around an object's viability. In the context of discussing how messaging can be informed by course structures, Kiara introduced the notion of considering "radical course structures," which Skylar affirmed as something that is "on the table" for the NIC to consider. After an energetic few seconds in which the NIC members laugh about possible pushback to more "radical" reform, Skylar proposed that reform could include grading structures. Senna, however, pushed back on this notion by referencing department expectations for calculus grades:

> The department does have this kind of, 'you shall not go above whatever' grades, which they're being a little more lenient about, but…a lot of times, the median grade out of 200 students is 100% on homework…if the whole grade was homework, the department would be like, 'What are you doing?!' You know? So there's kind of this like *[makes balancing scale motion with her hands]* (00:29:20)

In this way, Senna positioned radical grading structure reform (in this case, making grades purely based on homework) as something to which the department would push back on, and therefore

not a suitable object for the NIC. Because the NIC exists within the department, its actions are subject to departmental regulation. Senna's reference of the department becoming "a little more lenient" is likely in reference to KU's recent (within the past five years) deconstruction of the block grading system. Her perspective, however, indicates that the department still maintains some expectation of grade proportionality at KU even after this reform, but that the maintenance of that expectation is conducted more informally. Senna's discomfort with the idea that increasing grade dependency on homework–while hyperbolic in nature–exemplified the influence of department expectations in determining whether proposed objects were feasible for the NIC in conjunction with such expectations.

An additional community outside of the NIC frequently referenced is, perhaps unsurprisingly, students enrolled in KU calculus I and calculus II courses. Fairly early in the NIC meeting, Skylar asserted that "we want to center the student experience" in the NIC's shared object (00:13:43). Considering how the student community might perceive some of these objects also shaped the NIC's progress. For example, when considering #11, after Timothy had clarified that his intention was to reconsider (and possibly increase) the amount of credits given for calculus courses, Parker posed the following question: "Couldn't that have the opposite effect in some way, of students saying, like, 'I don't have the time to put one and a half credits into a math class right now'?" (00:20:20). This began a discussion in which Skylar, Parker, and Senna speculated on students' credit loads, using their own experiences and their perceptions of students' experiences as artifacts to inform the discussion. After a time, Senna intentionally sought the perspectives of Timothy and Ricardo: the two undergraduate students in the room. Timothy and Ricardo contributed by asserting the value of earning additional credits on a course, which Skylar, Parker, and Senna had dismissed in their speculations. Timothy began by agreeing

with this dismissal, but gradually both he and Ricardo assert the value of the additional credits though the following interaction (00:21:04):

> *Timothy:* Yeah, I mean if you want to do extra majors or course loads then usually [you have to take summer classes]. But I think that it's pretty easy to graduate on time, without–
>
> *Ricardo:* Yeah, but if you don't have AP credit, you either have to overload or do summer classes at some point.
>
> (*Anna:* Right.)
>
> *Timothy:* Also, if a student can underload in their last semester, or graduate early, that's meaningful too–
>
> (*Senna:* Oh, that's a good reason–)
>
> *Timothy:* Because it's very expensive. If you're putting in the time to do that much coursework, I think maybe it should be recognized.

Because Timothy and Ricardo are simultaneously a part of the NIC and a part of this outside community (the student population who experiences introductory mathematics at KU), they have particularly valuable insight with regard to the ways in which this outside community can inform a shared object. This interaction provides an example of how the NIC considered the experiences of the student population as an outside community that would be impacted by their shared object, and used it to inform the interpretation and value of a proposed object.

5.2.4: Artifacts

I've already alluded to several artifacts throughout the course of this analysis, and will explain them in more detail here, beginning with material artifacts that had physical (or digital) manifestations in the NIC's progress toward developing a shared object. The most central to their

progress was the list of anonymously submitted proposed objects. This list, shown in Table 9, consisted of proposed objects for NIC activity submitted by the NIC members independently during the week prior to the NIC meeting. Tiersa organized this list of submissions such that objects with similar themes were near each other on the list. NIC members were provided with physical printed copies of this list at the beginning of the NIC meeting, and on this list they organized initial thoughts on the proposed objects during the first eleven minutes of the meeting. The list was also projected onto a screen in the conference room. This list provided a clearly defined structure through which they discussed each other's anonymously submitted ideas, considered different themes that occurred within the proposed objects, and evaluated those objects, choosing to dismiss or combine them as decided. The NIC members also briefly leveraged phrasing from the Jamboard poetry reflections, an activity from earlier in the week in which they had reflected on poems. Discussion of these reflections served to put words to broad societal discontent with mathematics, highlighting the usefulness of a phrase from the poems: the "systemic perceptions of math."

In addition to these material artifacts, NIC members' development of a shared object was mediated by a variety of psychological artifacts. The artifacts of experiences–both personal experience and speculations on student experience–were especially salient to developing a shared object. For example, when considering what addressing messaging through a critical (structural) lens might look like, Skylar shared the following:

> Some of the hardest student comments I've gotten in course evaluations are ones where they say something like, "she really tries to emphasize a growth mindset in her syllabus, but she doesn't at all in the course itself." Like, if the math department really cares about

> a growth mindset, we should get rid of tests. Some say they should get rid of Professor [Skylar]. (00:27:03)

In sharing this vulnerable perspective, informed by the additional artifact of her course evaluations, Skylar provided the group with an example of what it might look like to consider "what I'm trying to communicate and what I'm actually communicating" alongside each other through the lens of student perspectives. She aimed to communicate a growth mindset to students, but recognized that this isn't always conveyed through student perceptions of her policies, prompting NIC members to consider the validity of an interrogation into how certain structures might convey (or not convey) various values. An additional example of personal experience being leveraged to mediate progress toward a shared object is when Senna pushed back on the notion of considering "radical course structures" (Kiara) that would eliminate exams. She shared that she has students in her courses who did not have exams in their previous mathematics course, and that now having exams in a course is a "traumatic experience" for these students (00:28:06). She noted that this was "really upsetting" and considered these students' experiences to be "the ugly side" of eliminating exams: that exams are still a part of many courses' structures and that, if students go from environments without exams into environments with exams, they will undergo negative experiences which she sees as mitigated by the continued implementation of traditional exam structures in mathematics courses. This anecdote effectively ended consideration of exam elimination, and further ended conversations around more radical changes to assessment structures as a prospective direction for a shared object.

In addition, NIC members' perceptions of students' experiences, whether anecdotal or purely speculative, informed the group's development of a shared object. Much of these perceptions and speculations were in reference to why students may be so dissatisfied with their

KU mathematics experience. As someone who had taken mathematics courses at KU several years prior, Anna shared that she "thought of KU math as being–the math department's being really good at trying to get students to think logically, analytically. My guess has been that that's why students don't like it." (00:39:52). As an undergraduate student who had more recently taken calculus I, Timothy then shared the following:

> From my perspective in the class, I think a lot of people have that mindset of, 'oh, in high school I was getting straight A's in everything and I was not struggling in all of my classes'…I think that when you actually have to really think for yourself and think on your own, it's like a really huge challenge. And I think that's why–regardless, I think that's a good thing for students, I think that might be why a lot don't like it as well. Just from what I've seen. (00:40:53)

In addition to affirming what other (instructor) NIC members have been framing as being a "good thing for students", Timothy affirmed that, as a student who was in calculus I, he also felt that critical thinking contributed to students' dislike of KU's introductory math courses. In a different line of thought, Senna asserted that "according to what I hear from students, they generally have devote a lot more work to their math class" than to other courses at KU, and that this may contribute to the frustration they feel. All of these perspectives serve in the continual refinement of understanding how students are perceiving the difficulty of KU's introductory mathematics program; something which they have identified as a common theme amongst many of their proposed objects.

In line with this desire to refine why KU students were dissatisfied with their mathematics experience was an additional psychological artifact which mediated the NIC's development of a shared object: perceptions of *rigor*. At the very beginning of the meeting, when

Tiersa asked what folks are noticing after some time to consider the list of proposed objects, Senna immediately responded, “RIGOR. Looking to decide, to understand what rigor means, how we repeat it” (00:12:32). Parker, Kiara, and Skylar all affirmed that they too saw this notion of rigor, particularly in objects #1-4. The fact that rigor was top-of-mind for folks when drafting and then assessing proposed shared objects could be contextualized by their NIC meeting on October 6th. At the very end of that meeting, they engaged in a discussion around the “issue with the rigor of [KU mathematics] curriculum” (Parker). In particular, they questioned whether the struggles students appeared to be facing were *unnecessary* or *necessary* dimensions of mathematical experience. In this prior NIC meeting, Parker initially asserted that KU math is unnecessarily rigorous, and Anna strongly countered that perspective, encouraging other NIC members to consider the notion of “a good challenge” in which a student is “pushed and felt good” contrasted with a “bad challenge” that could leave students feeling “beaten down.” Senna also contributed to this conversation by noting that she “doesn’t want to get rid of that rigor,” but knows that students complain about course difficulty. Having this be the final conversation of the previous NIC likely brought it to top of mind when folks considered what to draft as a collective object for NIC activity.

As the NIC members continued circling back to the concept of rigor as relevant to many of their proposed objects, Anna recognized a need to understand *what* they are discussing when they talk about rigor. She first asked for this clarification when Tiersa brought up the idea of considering “how much work we expect of students” and Anna asked whether volume of work is being considered as a dimension of rigor. Senna then clarified that, when she discusses rigor, she is talking about “can I give you something you haven’t seen before and have you tried it,” which Anna affirmed (00:32:49). However, Senna also equated rigor with coursework being

"unnecessarily difficult" shortly after (00:35:45). Later in the meeting, Kiara also brought in the idea of what kinds of mathematics are incentivized within a course as a dimension of rigor as well. Although the NIC never decided on an explicit, shared definition of mathematical rigor, the NIC ultimately decides to move forward with volume of work and rigor as separate constructs in their shared object.

These speculations on how students experience rigor at KU led into an ideological artifact that was also leveraged in this process of developing a shared object: paternalism, a characteristic of white supremacy culture. Jones and Okun (2001) provide several defining dimensions of paternalism, one of which is that "those with power think they are capable of making decisions for and in the interests of those without power" (p. 4). In the discussion of "rigorous practices" in KU math, those with power are those instructing the course, and those without power are the students who are perceiving those practices. This ideology was particularly apparent in remarks from Senna and Parker (00:33:07). Senna shared the following frustration in conversation with the NIC:

> The thing that [students] like to say that really gets me is, 'oh, KU wants to make it unnecessarily hard.' How do you get to decide what's necessary when you're taking a new course? I don't understand that, but, but, you know, that does make it sound like we're [making things difficult] for fun.

Senna's expressed frustration stems from the idea that students' perceptions of necessity when it comes to rigor (equated here with course difficulty) is invalidated because they haven't experienced the course before; in this way, Senna's statement implies that instructors should have the ultimate (if not all) authority over what is and isn't practiced within the introductory mathematics course. Parker followed this up with a similar sentiment, sharing with the NIC a

conversation she had with a student about the justification behind a particularly challenging homework question, in which she responds to the notion that the question was unnecessarily hard with her own perception that "no, there's a reason for it. There's a purpose behind it."

The homework question that was the topic of Parker's interaction with this student was assigned by Skylar. Ricardo, who had experienced the homework question during his time helping students in KU's tutoring center, contradicted Parker's justification of the question's value, offering the perspective that "it wasn't very clear where [the question] was headed." Upon hearing Parker's anecdote and Ricardo's contribution, Skylar admitted that she "think[s] she could've handled this question" differently, and that "it was challenging, and I…didn't give enough scaffolding." When Parker continually affirmed Skylar's instructional choices by asserting that the phrasing of the question was actually clear and prompted deeper understanding for students, Skylar backtracked and framed her self-critiques as "a note for herself" rather than something that would move forward the discussion toward a shared object.

This interaction created a paternalistic justification for maintaining a dimension of a shared object which focused on communication–specifically, communication that worked to convince students that there was a reason behind practices they may perceive as "unnecessarily difficult." Parker sums up these thoughts in the following statement:

> I think there's always gonna be a part to teaching that is like, "eat your vegetables. You've gotta do this, it's good for you, even if you don't see where it's good for you," but like, I think there's some piece we can communicate better and help them understand why it's good to eat your vegetables even if they'll still hate doing it.

This paternalistic conceptualization of rigor–as something needing to be justified, rather than interrogated and questioned–preserves the power of instructional perspectives over student

perspectives with regard to determining what is appropriate in introductory math courses. This is further evidenced by the fact that neither Ricardo nor Timothy contributed to the group's discussion of how to conceptualize rigor, and thus the artifact of rigor which mediated the development of a shared object was purely defined and leveraged from the perspectives of instructors. Viewing paternalism as a mediating artifact which overlaid this conceptualization of rigor brings to the forefront this more critical assessment of the NIC's development of a shared object.

5.2.4: Subjects

The CHAT dimension of the subject interacted meaningfully with many of the other dimensions I detailed thus far in this analysis. For example, the mediating artifacts of personal experience are necessarily tied to the subjects, as a personal experience is nonexistent without its subject; thus I consider personal experience as both an artifact and a part of the subject in this analysis. An additional example of personal experience interwoven into the NIC's progress toward a collective object was when Ricardo shared his experience in introductory chemistry in response to Senna and Anna seeking to understand why introductory math had a more negative reputation than other introductory STEM courses at KU. Ricardo shared that he "enjoyed chemistry in high school, and I hated taking chemistry here," noting that "I just don't think I vibed with the professor I had," but coming to the conclusion that his peers more readily succumbed to a "herd effect of hating on math" moreso than they expressed discontent with chemistry. This opened up a brief discussion around students' "trauma bonding" (Senna) from hating mathematics as the NIC continued to speculate on what attributes of KU math were contributing to students' negative experiences.

Similarly to the *artifact* of personal experiences, the intra-NIC power dynamics that I will discuss in the *divisions of labor* section are intimately tied to the subjects and their identities. Subjects' identities (such as race, gender, citizenship status) and social connections within the NIC are also situated in the CHAT dimension of "subject" and would necessarily impact these power dynamics, which impact whose voices are treated with authority, which therefore impact the development of the shared object. This is detailed with respect to professional identities in the section on *divisions of labor*.

I highlight the relative difficulty in identifying components of this collective discussion which were situated squarely in the CHAT realm of *subject.* This difficulty aligns with the original reasoning for constructing the CHAT framework; Vygotsky's (1978) assertion that activity was mediated, and Leontiev's (1978) and Engeström's (1987; 2001) subsequent considerations of collective action, were all informed by an understanding that activity is greater than a simple connection between subject(s) and object. Considering I did find it appropriate and doable to explain the other dimensions of CHAT in relative isolation, I find this an interesting conundrum that will be greater discussed in Chapter 6 of this dissertation. While I can speculate on certain connections in that chapter, it is worth noting here that NIC members did not bring their personal motives explicitly into discussion.

5.2.5: Divisions of Labor

The CHAT dimension of *divisions of labor* manifested in the NIC's development of a shared object in two principle ways: through Tiersa and Skylar's leadership, and through intra-NIC power dynamics. The former manifested in several ways which I have already highlighted as CHAT dimensions which impacted the development of the shared object. For example, the rule of being democratic, and its subsequent influence on the structure of the

October 27th NIC meeting, was defined by Tiersa and Skylar. In addition, the rule of be critical was principally communicated through Tiersa and Skylar's perception of criticality; because NIC members were not present for the Summer 2023 Leadership Workshop or the ACT UP Math project team meeting in which we discussed the need to be critical in ACT UP Math work, it was up to Tiersa and Skylar to define for the NIC what exactly this rule entailed, and communicate that definition accordingly.

Further, Tiersa and Skylar were responsible for final affirmations of decisions made in the process of refining a shared object. In many cases, because Tiersa was in control of the editable list of proposed goals, she took the lead on drafting combinations of goals, and making notes on how to best move forward. As the NIC discussed the fact that some goals (such as #9 and #11) could be done in conjunction with more action-oriented collective goals, Tiersa asserted that she will combine these objects into a "monster goal" which combines many of these ideas. In addition, Tiersa and Skylar principally provided transitions between topics in the NIC, and were responsible for moving the conversation forward in the instance of a lull.

While all NIC members shared in the responsibility of drafting proposed objects for NIC activity, Tiersa created the principal artifact–the list of proposed objects–and intentionally grouped them based upon the themes she saw prior to presenting them to the group. She was also responsible for documenting NIC members' thoughts through adding digital comments to the document which was projected up on the screen. These comments mostly related to different themes NIC members noticed; for example, she highlighted proposed objects #5-#8 and wrote the following: "Communication from the department and how that interacts with student feelings" and "Messaging and how does this change the course structure?" These notes provided documentation for the NIC members of their earlier discussions, and informed their phrasing

decisions when they went to draft the refined proposed objects in Table 10. There were many cases in which her notes adhered directly to phrasing shared by NIC members; for example, Skylar's proposition of "eliminating" proposed object #11 or Kiara's articulation of the "monster goal" in the following way: "interrogate how much work we expect of students, and then ask what is credit-based, what's not credit-based, and then how do students respond to that." Kiara's articulation directly translated to the creation of Goal A, the shared object which they then voted to pursue. In this way, Tiersa was responsible for documenting ideas, and could determine the fidelity of that documentation to NIC members' original expressions.

The second way in which divisions of labor manifested was through professional power dynamics which determined who could or could not speak on a subject relative to their experiences. I make explicit that these power dynamics will be discussed in terms of professional identities (undergraduate students, graduate students, faculty members) and not in terms of social identities, although such social identities undoubtedly play a role in how power and authority manifest within the NIC. This is done, as explained more thoroughly in Chapter 3, to maintain anonymity of participants in a way agreed upon between the local NIC participants and the research team. With regard to the professional identities of participants, one noticing that arises from the NIC's development of a shared object is that authority to speak on student experience was universally distributed–that is, anyone in the NIC could speak to how students experience KU mathematics. And indeed, every NIC member did, at least once. However, those who could speak on the instructor experience were limited to those who had instructional experience. This left Timothy and Ricardo out of much of the conversation. The NIC had spent significant time in the previous NIC meeting on October 6th explicitly naming their areas of expertise; this was done as an intentional effort by Tiersa and Skylar, in collaboration with myself and other

members of the ACT UP research team, to position every member of the NIC as a valuable contributor with unique experience that enabled them to speak to certain dimensions of KU mathematics, with particular focus on positioning student members as experts on student experiences in KU mathematics. Table 11, constructed from field notes of that meeting, elaborates on the areas of expertise which they all shared.

Table 11. Self-identified areas of expertise from NIC members during their October 6th meeting.

NIC Member	*Self-identified Areas of Expertise*
Skylar	Course coordination, instruction, design, and community organization
Kiara	Instruction of recitation courses, gender identity and its interaction with math
Senna	Advisorship, long-term experience with KU math
Tiersa	Familiarity with other institutions' practices
Timothy	Experiences as a student who is not majoring in math
Ricardo	Tutoring, international student experiences
Anna	K-12 mathematics education, engineering experiences
Parker	Minority student experience, emotions around mathematics

In practice, evidenced by this process of collective goal generation, *all* NIC members were positioned as experts on current student experiences in KU's introductory mathematics courses, including those who held purely instructional roles. Expertise around instructional and administrative practices was more differentially distributed; only those who presently held instructional identities (the faculty and graduate student members) could speak to the instructional experience of calculus I and calculus II. This differential expertise distribution connects to the ideological artifact of paternalism, in which individuals with power (instructors) are seen (or perceive themselves as) the authority on the experiences of those without, or with less, power. It is worth noting that outcomes of decisions which impacted their development of a

shared object changed significantly when the specific experiential expertise of undergraduate students was brought in and deferred to; take, for example, the conversation about potentially changing the credits provided for calculus courses, detailed in the *community* section. For example, Parker shared that "having enough classes, I feel like that's not an issue most of the time." Hearing from Timothy and Ricardo on this issue, in which they brought up the perspective that graduating early can have major financial implications, or that additional credits could serve to benefit the progress of students who aren't coming in with AP credits, then shifts the other NIC members towards reconsidering and keeping #11 as a prospective object as opposed to eliminating it, as Skylar had earlier suggested.

As a reminder, the dimensions of CHAT articulated above are interwoven and necessarily dependent on each other (Roth & Lee, 2007). While I have parsed them out as concepts to structure a mini-ethnographic case study analysis of how the NIC came to a shared object, this analysis is done with the knowledge that truly parsing out these CHAT dimensions is impossible. However, understanding what is emphasized in each dimension enabled an in-depth look at what proved salient as the NIC developed their shared object. In the following discussion, I provide a critical interpretation of the ways in which some of these CHAT dimensions interact and elaborate on future work resulting from this analysis.

5.3: Discussion

Leveraging cultural historical activity theory (CHAT) as a conceptual lens through which to understand the KU NIC's collective object generation yielded greater understanding into the components which impacted their development of a shared object for their work: to investigate expectations of volume and rigor of work in KU math, considering how these are credited in courses, communicated, and how students respond to shifts in these components of instruction.

Their conversation centered around one particular artifact: a list of anonymously submitted goals, created in line with the rule of *be democratic,* enacted by the NIC leaders in their structuring of the meeting. Throughout this NIC meeting, their interactions refined ideas present in this list through pulling in other mediating constructs from the dimensions of CHAT, such as the implicit and explicit rules governing the NIC. In this discussion, I look across this CHAT-informed case study to more critically interrogate the NIC's collaborative construction of their shared object. I first discuss the primacy of instructors' personal experiences and perceptions of student experiences as artifacts, in relation to these position undergraduate student perspectives. I also consider the risk of identity neutrality in the collective object generation of the NIC. I conclude this section with implications for reform efforts in undergraduate mathematics education spaces, and opportunities for future work based upon this mini-ethnographic case study.

5.3.1: The Primacy of Instructors' Personal Experiences and Perceptions

As elaborated in both the *subjects* and *artifacts* sections of the Findings, personal experiences and personal perceptions of students' experiences played a pivotal role in informing the generation of the NIC's collective object. Wager and Foote (2013) point toward the importance of K-12 mathematics teachers' lived experiences in how they engage with equity-oriented professional development. Although ACT UP Math is not explicitly a professional development effort, we see a parallel with this assertion in the undergraduate mathematics context through the ways in which personal experiences and perceptions influenced what the KU NIC developed as a shared object for their work. Instructors' personal experiences played important roles, in particular with regard to how they related to the CHAT concept of *communities*. The knowledge of NIC members with regard to other initiatives within the department and broader university

through their own experiences was a massive asset in shaping what they decided was or was not appropriate for the NIC to consider as a shared object. For example, Anna's involvement in the Curriculum Committee and Skylar's involvement on the departmental DEI committee provided the NIC with a broader context of what was happening at the department and institution level. Instructors are also experts on their own instructional experiences; Parker and Senna both provided narratives of salient interactions they had with undergraduates during office hours to contextualize how students might be feeling about the rigor of their coursework. The personal experiences of Tiersa and Skylar with the previous Spring 2023 NIC members helped inform their implementation of the rule *be critical* with relevance to messaging goals, leading to a conversation about whether messaging could be critically incorporated into a shared object. In these ways, personal experiences served productive roles as the NIC members engaged in collective object generation.

A more critique-oriented approach comes from considering how students' voices and perspectives were positioned (and often marginalized) in the context of this conversation, in favor of instructors' own perceptions of student experiences. As I discuss the prevalence of personal experiences and perceptions to the development of a shared object, I principally consider the personal experiences and perceptions expressed from an instructor perspective–a professional identity available to six out of the eight KU NIC members. One of the undergraduate students also works in KU's mathematics tutoring center, and thus also had access to an instructional perspective. Given this majority identity, it is perhaps not surprising that most of the discussion in this NIC meeting came from an instructor perspective, with the personal experiences of undergraduate students only playing a role to contextualize observations already made by instructors. Skylar expressed an awareness of the possibility of instructional

perspectives dominating the conversation with such a NIC composition in a journal entry at the beginning of Fall 2023:

> I'm very happy we now have student members of our NIC…but I'm also aware that the returning members are all faculty and that all but one member are actively involved in the teaching activities of the department, and that one member might feel othered as a result.

This quote indicates that Skylar, as a NIC leader, was aware of how the instructional perspective might dominate the conversation.

The primacy of instructors' experiences and perceptions to the NIC's collective object generation is evidenced both by how the perspectives of undergraduate students within the NIC and undergraduate students outside of the NIC are positioned. The former can be dissected in the context of the *divisions of labor* dimension of CHAT. The contributions of Ricardo and Timothy, the two undergraduate students in the NIC, were predominantly used to provide further context on a possible object brought up from an instructional lens. The undergraduate students provided valuable context to such objects; for example, Timothy and Ricardo both contributed to the instructor NIC members' enhanced understanding of why increasing the credit value of calculus courses may be a worthwhile endeavor. Simultaneously, the centrality of an instructor lens to the discussion marginalized the ways in which the undergraduate students were given space to participate, and positioned their contributions mainly in service of others' ideas. The marginalization of undergraduate students' contributions is evident both quantitatively (how much did they contribute?) and qualitatively (what did they contribute and how was it received?). A quantification of the number of independent verbal contributions (including verbal affirmations like "yes" or "okay") throughout the conversation is shown in Table 12.

Table 12. A quantification of the number of verbal contributions made by each NIC member in the context of the analyzed conversation.

Number of Verbal Contributions During October 27th NIC Meeting							
Skylar	**Tiersa**	**Anna**	**Senna**	**Parker**	**Kiara**	**Timothy**	**Ricardo**
198	51	81	120	71	75	**15**	**12**

Engagement can occur through forms beyond verbal contributions (Fantin-Hardesty et al., 2023), and Timothy and Ricardo's engagement throughout the meeting is evidenced by their nodding, laughter, and attentive body language throughout the meeting. However, the quantitative comparison of verbal contributions reveal a stark difference in how often they verbally contributed compared to their peers in the NIC. Tiersa and Skylar were very intentional about wanting to bring students in as partners in this work (Bolick et al., accepted), and chose to bring in two undergraduate students and two graduate students. While Table 12 does not account for qualitative differences, the quantification is stark enough to warrant criticality with regard to how undergraduate students' perceptions and experiences are being positioned in a context in which they are intended to be meaningfully incorporated as partners in the work.

Exploring Timothy and Ricardo's contributions more qualitatively indicate that in a majority of cases, they contributed when they were asked to weigh in on an instructor's perspective or idea. Consider the contributions of Ricardo, of which there were five that went beyond simple verbal affirmation. Three of these six were explicitly sought out to contextualize instructor perspectives on students' credit loads, student experiences of undergraduate chemistry, and whether food was a reasonable incentive for focus group participation, respectively. These contexts proved important (for example, how Ricardo and Timothy's contextualization of student credit loads resulted in the group keeping language about credit loads within proposed objects), but were considered in the context of a conversation principally happening between instructors

from an instructor lens to add a student context to an instructor's idea. Ricardo also at one point contradicted a point made by Parker about the appropriateness of a particular problem for calculus students, noting that the problem in question was actually not very clear. While Parker did not take up Ricardo's perspective and continued articulating that the problem *was* appropriate, Skylar appeared to implicitly recognize Ricardo's perspective through her reflection that perhaps she could have scaffolded the problem better for her students. Ricardo's only other contribution in the context of this NIC meeting was providing the perspective that students are less likely to fill out lengthy surveys, affirming a perspective that was already introduced by Senna that students would not respond to longer data collection instruments. A similar positioning of undergraduate student NIC members has been observed across the project in AU's NIC, particularly with regard to when the undergraduate students shared their personal experiences; they observe the following:

> There were numerous moments where the student NIC members would reference personal experiences in math that would spark conversation and be incorporated into the process of the group choosing topics of conversation. However, these conversations often *continued amongst faculty with limited student interjection*, minimizing or failing to attribute the role that students played in initiating the discussion. (Bolick et al., accepted, p. 6, emphasis added)

Undergraduate student feedback is similarly positioned in the KU NIC's conversation; while it is incorporated into the conversation around developing a suitable object for reform, the conversation around such reform continues amongst members of the NIC with instructional identities. The mechanisms of why or how this happens could be better detailed through a conversational analysis, which I will discuss further in *Future Work* below.

The primacy of instructors' personal experiences and perceptions surfaces another mediating ideological artifact: paternalism. As articulated in the section on *artifacts*, Jones and Okun (2001) provide several defining dimensions of paternalism, one of which is "those with power think they are capable of making decisions for and in the interests of those without power" (p. 4). This appeared in the KU NIC through rhetoric such as Parker's assertion that students need to "eat their vegetables" and engage in practices they may not like in undergraduate mathematics courses, and Senna's questioning of "how do [students] get to decide what's necessary when [they]'re taking a new course", which point to a lens of knowing better than students about what they need within their mathematics learning. Paternalism in this context serves to dismiss the ways in which students express concerns about KU math, an additional example of how perspectives expressed from a student point of view were not always deemed salient to the NIC's collective object generation, and thus superseded by instructors' own perceptions of what might be important to preserve or change within reform efforts. Growing past paternalism is a key part of developing as an equity-conscious practitioner of mathematics education (McNeill et al., 2024), and thus it is worth exploring what might be done to disrupt paternalism within collaborative spaces.

Jones and Okun (2001) present several *antidotes* for paternalism, one of which is to "include people who are affected by decisions in the decision-making" (p. 4). Including Timothy and Ricardo within the NIC is in line with this antidote. Students meaningfully contributed (albeit infrequently) to the NIC's progress toward a shared goal through advisory roles; their contributions generally acted as feedback for instructor ideas. In one notable instance, Timothy, who expressed having had a particularly difficult experience in calculus, does explicitly counter a paternalistic perspective. In response to Parker's assertion that students need to "eat their

vegetables," he shares his own perceptions of students' struggles to transition from high school to KU math. In this response, he walks a line between validating Parker's perspective and affirming the reasonings with which students might critique the challenge of KU math, saying "regardless, I think [rigor as critical thinking]'s a good thing for students, I think that might be why a lot don't like it as well. Just from what I've seen." Timothy provides a perspective which simultaneously seeks to assuage the paternalism expressed by other instructor members of the NIC, while also seeking to provide an alternative affirmation of student perspectives. In this way, having someone in the room who was an undergraduate student and had access to that community and those experiences did serve to create initial disruption of a paternalistic perspective, while still existing within the power dynamics of the NIC itself.

In addition to making more space for Timothy and Ricardo to contribute foundational ideas and valuing those contributions in ways which supersede instructional perceptions of student experience, another way to disrupt paternalism in educational reform by "includ[ing] people who are affected by decisions in the decision-making" would be to more foundationally rely upon data provided by students about their experiences. Kiara in particular reflected on this importance of this in the following journal excerpt:

> As instructors, we have a limited perspective on what our students are experiencing. We have some, but, you know, not all. And I think it's a helpful reminder that, like, very concretely through data, it's a helpful reminder that we need to be careful. We need to remember that students are the experts in their lived experiences. And by hearing from them, that is gonna be the most accurate way to know what's going on.

In this excerpt, Kiara is recognizing the value of relying on student data to inform decision-making as something which explicitly disrupts the dominance of instructor perspectives. As

mentioned in Section 5.1, the KU NIC had access to several sets of data, including SPIPS-M data, the KU Survey data, and focus group data collected the previous semester. Given the explicit data-driven nature of the ACT UP Math project, one would reasonably expect data to be a mediating artifact in object generation for the KU NIC. However, we see that, while *be critical* and *take collective action* are rules connected to the broader ACT UP Math project, the NIC members do not take up a rule related to data use, although this exists alongside criticality and transformation in the broader objectives of ACT UP Math. With the absence of such a rule, I observe that data about student experiences–in particular, differential student experiences based upon identity markers–were not once referenced in service of collective object generation. In the latter half of the meeting, in which they discuss how they might measure a "baseline" for their proposed object, a conversation between Skylar, Senna, and Anna effectively dismissed the relevance of the SPIPS data in particular because of its timing in relation to previous KU reform efforts. Senna states the following:

> [The SPIPS data] was long enough ago that I also wonder…I'm not saying it's invalid data, but I think we've tried–made a lot of efforts since then to try and fix things? Obviously they're not still where we want them to be, but I wonder if it was maybe potentially that student morale was even worse then. (00:54:34)

Skylar affirmed that the SPIPS-M data were collected some pre-COVID, which preceded recent reform efforts made by the department. Anna expressed surprise that the data was collected so long ago. This conversation serves to dismiss the SPIPS-M data in the context of developing their shared object, as it is positioned as irrelevant due to its timing.

In a meeting with Tiersa and Skylar shortly after the NIC had developed their collective object, we sought their perspectives on how data informed this development. They shared with

the research team that they felt the SPIPS-M data on how students rated their confidence before and after taking a KU calculus course informed their collective object, because their NIC had previously connected rigor to confidence in their discussion during their October 6th meeting. They also felt that student survey data of the words students used to describe KU math informed their collective object due to its emphasis on challenge and unnecessarily difficulty within the program. While it is certainly possible that these data sources informed the NIC's interest in developing a rigor-centered object or informed their anonymously submitted proposed objects, these data never appeared in their collective conversation around what the shared object of their NIC should be. Thus, these data may have contributed to the context within which this object was developed, but did not serve the development of the object itself. It is also interesting to consider the NIC leaders' assertion that the SPIPS-M data did play a role in shaping their collective object, in light of the apparent dismissal of its relevance due to its timing.

Without data on differential student experiences–data which are self-reported by students and therefore come from a student perspective–as a grounding factor within the object development conversation itself, the instructional lens of the NIC members is permitted to take center stage in identifying important student issues at KU, and thus what is important for the NIC to tackle within KU's introductory mathematics program. Perceptions of how students experience KU math, often informed by anecdotes, are interwoven throughout the conversation. For example, the many ways that the NIC members define rigor–as volume of work, as an ability to expand beyond material covered in the course, as unnecessary difficulty, as critical thinking, or as what is incentivized within the course–are all personal conceptualizations of what rigor is. The notion of rigor itself as an appropriate central focus for the NIC's object comes from personal perceptions of students experiencing KU math as "unnecessarily difficult", a

conversation which was begun at the October 6th meeting and built upon in their collective object generation. The reliance on personal perceptions of important foci for reform does not mean that rigor is *not* something salient to confront in the context of reforming KU math, but does reduce the fidelity of this shared object to students' own experiences of KU math because it stems from instructors' assertions of what would be impactful to reform.

5.3.2: Identity Neutrality in Collective Object Generation

Without incorporating data which explicitly focused on differential student experiences (such as the SPIPS-M data and the KU Survey data), we find that the perceptions of students' experiences expressed by the NIC took on a "for all" stance toward equity reform. As articulated in Chapter 4, identity neutrality can often counter the professed aims of equity-oriented reform efforts (Martin, 2003). This is particularly interesting in light of the NIC's rule of *be critical*, as criticality by Gutiérrez's definition explicitly incorporates identity. However, the way in which the NIC defined criticality for themselves–as attention to systemic and structural aspects of undergraduate mathematics education–does not necessitate such explicitness with regard to their reform efforts. In their October 6th meeting, the notion of criticality encompassing attention to identity is subtly (and likely unintentionally) dismissed; Skylar shares with the NIC that they know from the SPIPS data that students of color leave mathematics coursework in disproportionate amounts. She then notes, though, that a critical perspective is not a focus on the students, but a focus on *systems*, asserting the definition of criticality exemplified in the *be critical* rule which mediated their collective object generation.

The result was an identity-neutral discussion leading to an identity-neutral shared object. Interrogating rigor and volume of work is framed as something that is intended to benefit *all* students. This result does not contradict any other dimension of the CHAT framework with

regard to their collective object generation. It does not contradict any of the rules which guided their conversation, as the *criticality* of the work is not conceptualized as including explicit attention to identity. Felix and Trinidad (2019), in documenting California state-wide community college reform for racial equity, note that race in particular is frequently de-emphasized or eliminated from the reform itself, asserting the following:

> If policies and their supporting documents fail to include racial discourse, then the receiving implementers on campus must be equipped with the knowledge and competencies to develop the reform effort in ways that achieve its goals of equity for racially-minoritized students. (p. 483)

In the context of developing their shared object, the NIC failed to include equity-oriented discourse rooted in differential student experiences; this then jeopardizes their path toward meaningful equity-oriented reform by framing the effort as something which is designed to benefit all students. The concept of rigor acts as a gendered and racialized gatekeeper within STEM education, and is often invoked to reinforce social and academic hierarchies (Riley, 2017); an interrogation into rigor could have very important and beneficial repercussions for KU's undergraduate mathematics students of color and gender marginalized students. However, without attention to differential experiences of such rigor–which is not immediately apparent from the NIC's collective object nor the conversation from which it arose–the NIC's reform efforts run the risk of diluting possibilities for effective reform in the interests of marginalized populations.

5.3.3: Implications

It is impossible to remove lived experience from the development of reform, and instructors' personal experiences and perceptions of student experiences can serve as valuable

assets in many ways to the process of reform. As mentioned near the beginning of this discussion, explicitly incorporating personal experiences and perceptions in the process of collaborative reform enables attention to impactful issues, diverse perspectives within the discussion, knowledge of other communities with which individuals interact, and can serve to disrupt paternalism. In observing the primacy of personal experiences to K-12 teachers' engagement with professional development, Wager and Foote (2013) write the following:

> Although it seems obvious that personal experiences contribute to the formulation of our beliefs and the way we act, as we know from our many experiences participating in and facilitating PD, facilitators do not always take into account the ways in which teachers' lived experiences contribute to their beliefs about and the way they practice teaching. In some situations, a teacher may need to confront prior experiences before making a change in practice. Thus, to understand teachers' practices, not only is it useful for teachers to examine past experiences but it is also helpful for them to consider the ways those experiences have contributed to who they are. (p. 24)

In addition to the assets that personal experiences and perceptions can bring to a collaborative environment such as that of the NIC, there exists a need to critically analyze the impact of the dominance of those personal experiences and perceptions in the context of equity-oriented reform designed to serve undergraduate students in introductory math courses.

As a research team, we were surprised that it was personal experiences and perceptions, rather than data, which guided and foundationalized the NIC's formation of their shared object. Considering that many KU NIC members valued the data-driven nature of the ACT UP Math project in their journal entries and interviews, the dominance of personal experiences and perceptions is even more striking. Crandall and Schaller (2013) observe a disconnect in the

context of norms of scientific disciplines, finding that personal interests in service to the maintenance of power superseded abstract ideals for what science should be. Fostering *data-informed* change in the context of the NIC's work appears to be one such abstract ideal superseded by personal interest, as the collective object was generated without discussion of data. A more explicit reliance on data to inform a collective object may have further prompted a greater attention to differential student experiences. Dowd and Leira (2018) note that the use of data in the construction of equity-oriented reform is most productive when the following are true:

1. It is mediated by cultural tools designed to promote inquiry about equity as a standard of practice.
2. Data discussions take place in a time and space where practitioners can grapple with the institutional role in producing racial inequities.
3. Change efforts are carried out in an iterative manner to enable discursive and data tools to be redesigned for use in new settings.

At a surface level, the ACT UP Math team adhered to each of these recommendations. We developed an interactive data dashboard (see Bolick & Voigt, 2023), we created and shared slides with reflection questions to support exploring the data during or outside of NIC meetings based on the NIC leaders' preferences, and our project entails multiple iterations of planning, acting, and reflecting on change initiatives informed by data. However, something about our approach still resulted in data dismissal in favor of personal experiences, indicating that there are ways we might have better supported or more explicitly emphasized the need to be data-driven in developing objects for NIC activity. Perhaps this is due to a key difference between Dowd and Liera's work and the ACT UP Math project: the centrality of race. Without encouraging the NIC to focus on a specific social marker, we assumed they would leverage the local data (in KU's

case, SPIPS-M and the KU Survey data) to choose a certain demographic group to focus their efforts toward supporting (Hagman et al., 2024). As this did not happen and thus the NIC did not have a central focus regarding *who* they wanted to improve undergraduate mathematics programs *for,* it was perhaps easier to view their own perceptions as more relevant because no identity group was considered. Supporting folks in better leveraging data may therefore go hand-in-hand with supporting them to be explicit in selecting a particular identity focus for their reform efforts.

In order to reduce the influence of paternalism on decision-making in undergraduate mathematics reform that can also stem from the centering of personal experiences and perceptions, I want to build on Jones and Okun's (2001) recommendation of bringing folks who will be impacted by decisions into decision-making spaces. In the ACT UP Math context, we conceptualize this as positioning students (both undergraduate student NIC members and students from whom data are collected) as experts on their own experiences (Bolick et al., accepted; Hagman et al., 2024). As evidenced by Tiersa and Skylar's journal entries, the KU NIC was very excited and intentional about incorporating undergraduate students into decision-making spaces. However, the dominance of instructor experiences and perceptions, in conjunction with intra-NIC power dynamics, maintained existing hierarchies between instructor and student viewpoints on KU mathematics, evidenced by the large disparity in verbal contributions to the conversation and ongoing instances of expressed paternalism. Drawing on the language used by the ACT UP Math project, I argue that in order to meaningfully and critically incorporate student perspectives into reform efforts, there exists not only a need to position *students as experts* on their own experiences, but to further position *instructors as novices* on student experiences. Parker notes that "students don't see the teacher brain behind it"

(00.34:18) when justifying a calculus student's negative experience; what would it look like to consider that instructors don't fully see the student brain behind student experiences?

This suggestion weaves together several of the points I've discussed in this section. While the NIC members did take time to reflect on their areas of expertise (see Table 11 in the Section 5.2), they did not partake in any meaningful reflection about areas in which they could learn from each other or from the data: areas in which they are *novices*. Making explicit in this context that student perspectives are valuable and should be upheld as *the* authority on how students are experiencing mathematics, regardless of instructor perception of those experiences or whether certain experiences are "good" or "bad" for students, could serve to disrupt the dominance of instructor experiences and perceptions of experience in shaping a collective object for reform efforts. Positioning oneself as a novice then requires seeking more expert perspectives–in this case, the expertise of students within the NIC and data from KU mathematics students–to provide a foundation upon which reform can be built.

This does not mean instructors do not contribute valuable knowledge to reform. As evidenced by this collective goal generation process, instructors often have a wealth of knowledge about the structures and systems within a department, how prior attempts at reform have been received, and what barriers and affordances might exist within communities to argue for or against particular courses of action. They also have deep content- and discipline-specific knowledge that can inform successful reform efforts. Instructors are *experts* in these areas, and others. However, as we saw in the KU NIC's collective object generation, when instructors are also positioned as experts on students' experiences, the ability of students to act as experts on their own experiences is diminished. I also clarify that this does not mean students' suggestions should be taken at face value, but rather should be treated as valid, indicative of a specific

experience, and able to be contextualized using the knowledge of instructors in the larger context. Consider the following statement from Senna:

> The thing that [students] like to say that really gets me is, 'oh, KU wants to make it unnecessarily hard.' How do you get to decide what's necessary when you're taking a new course? I don't understand that, but, but, you know, that does make it sound like we're [making things difficult] for fun. (00:33:07)

Instead of questioning whether students know enough or hold enough authority to question the difficulty of material within a class, or the reasoning behind that difficulty, it might be productive to recognize that students are experiencing KU math as difficult in a way that doesn't feel *necessary*. For Senna, as the instructor of a calculus course and recipient of this feedback, this would look like dispelling feelings of defensiveness to then contemplate why the difficulty of KU math feels unnecessary to students. Is it because the problems are indeed more difficult than students feel supported to tackle? Is it because the coursework does not connect to their lived experiences or interests? Is it, as Timothy suggested later on in the meeting, because students haven't been supported to engage in the kind of critical thinking KU expects of them in their prior K-12 math courses? Instead of dismissing students' perspectives as lacking authority because they do not *also* have instructional experience, it is important to frame instructional perspectives on reform as insufficient without the serious and meaningful inclusion of student perspectives to disrupt paternalism in the process of crafting transformative change projects.

5.3.4: Future Work

As discussed in Chapter 3, this investigation leveraged CHAT as a conceptual framework and theoretical grounding through which to perform a mini-ethnographic case study. It also opened the doors for interesting lines of CHAT analysis (Engeström, 2001; Núñez, 2021; Roth &

Lee, 2007). These analyses would require considering not only the rules, communities, divisions of labor, and artifacts which mediated the NIC members' creation of their shared object in this October 27th conversation, but would bring in data from across the 23-24 academic year to construct a robust understanding of what rules, communities, divisions of labor, and artifacts mediated the object-oriented activity of the local NIC beyond this one instance of development. This mini-ethnographic case study analysis has set the stage for such an inquiry, particularly through the identification of the rules which guided NIC behavior. CHAT analyses are rooted in the identification of a contradiction among the dimensions of an activity system; below, I articulate one contradiction which arose throughout the course of this mini-ethnographic case study which could serve as the foundation for a future CHAT analysis.

Shortly after the conversation presented in this case study took place, the NIC members engaged in reflexive journaling, in which they were invited to discuss their NIC's progress. While all members appeared excited about their shared object in the context of the October 27th NIC meeting dissected in this mini-ethnographic case study, several later expressed discontent with their shared object. For example, one NIC member shared that they had "mixed feelings" about the progress the NIC was making, noting that it "[felt] nice to have coalesced around a goal" but simultaneously "it isn't as concrete as I was hoping going into the NIC." In expressing their frustration, they note that the NIC "reflected on rigor and wrote down some goals but didn't work on those goals." A desire for more action is also evident in another member's journal entry, in which they note that they "want to start taking big actions! Or small actions. Just some kind of action!" This is particularly interesting considering that *taking collective action* was one of the rules that shaped their object development; however, the object that they developed was more focused on data collection, which they intentionally distinguished from action as they

endeavored to err toward action. Thus a disconnect was created between the shared object of the activity and one of the rules, and the discontent of the subjects with regard to the lack of action-orientation within NIC activity served as an indicator of this contradiction. A CHAT analysis could clarify further how this disconnect arose, mediated by other dimensions of NIC activity, and provide an informed direction for re-mediation.

In addition to CHAT analyses informed preliminarily by this mini-ethnographic case study, it may be interesting to consider more critical conversational methodologies to better understand the positioning of undergraduate student perspectives within the NIC's discussion. Working with students as fundamental collaborators in higher education reform efforts is complex, and can take many forms, but there exists a need to begin understanding how such partnerships can influence the transformation of institutional cultures (Mercer-Mapstone et al., 2017). Given the quantified disparity in verbal contributions between the KU NIC's undergraduate student members and the NIC members who occupy instructional roles at the university, a conversational analysis may be appropriate in considering how those perspectives are being responded to as the NIC works toward this shared object. My summary of Ricardo's contributions in *The Primacy of Instructors' Personal Experiences and Perceptions* section provides an informal look at how contributions were sought and how they were responded to, but methodological tools could allow for a more rigorous analysis of this positioning. A critical conversational analysis, such as that described by Wilkinson and Kitzinger (2008), could prove useful through an emphasis on how speaking turns are initiated (i.e. Senna explicitly asking for Timothy and Ricardo's perspectives) and how NIC members might adhere to preferred responses as they navigate the intra-NIC power dynamics (i.e. Timothy saying that rigor is important for students, in line with instructors' perspectives, while attempting to assert that this rigor

contributes to students' negative experiences). It may also be interesting to consider the use of the EQUIP tool in the context of reform-oriented conversations such as the one analyzed in this case study. Reinholz and Shah (2018) present EQUIP as a way of coordinating analyses of mathematics classroom discourse with students' demographic markers to better identify patterns in classroom participation. The use of this tool has led to useful reflections on instructional behavior (e.g. Byun et al., 2023; Stone-Johnstone et al., 2023). EQUIP is ripe for use in understanding how participation is (in)equitably distributed within the context of student partnerships for equity-oriented reform. Notably, however, this investigations' inability to connect NIC members' social identities (such as race and gender) to their individual contributions would limit the power of the EQUIP tool, and as such it would be interesting to consider applying EQUIP to a similar context in which such social identities could be ethically incorporated through agreement with the participants.

In summary, this CHAT-based mini-ethnographic case study is poised to provide a foundation for future analyses focused on tensions and contradictions within a NIC using a CHAT analysis. The dominance of instructor perspectives in developing the shared object of the NIC and disparity between the contributions of undergraduate students and instructional NIC members could also be further dissected through a more detailed conversational analysis. Overall, this work provided a look into what components of each CHAT dimension contributed to one NIC's development of a shared object, and yielded insight into the continued need to confront paternalism and identity neutrality within discourse in undergraduate mathematics education, specifically in the context of proposed reform.

CHAPTER 6: DISCUSSION AND CONCLUSION

Responding to Larnell's (2023) call that equity work become a shared responsibility among members of the mathematics education community necessitates understanding what prompts individuals to take a responsive stance toward DEI issues. As we work to call in more folks to engage with this work, it becomes important to understand how individual beliefs or values might impact the outcome of work itself. Looking at one particular equity-oriented reform effort–the ACT UP Math project–I sought to begin bridging this gap of individual and collective dimensions of reform activity through a CHAT lens by studying *objects*, or motives, at the individual and collective level. In this section, I will provide brief summaries of the two investigations (individual motives and collective object generation), and then elaborate on similarities, differences, and possible connections between the findings of the two. Finally, I conclude by theorizing how to better synthesize individual and collective analyses in the context of studying reform in undergraduate mathematics departments, and discuss opportunities for future work stemming from these two investigations.

6.1: Summary of the Two Investigations

The first analysis looked at individual motives for joining an ACT UP Math Networked Improvement Community (NIC), as expressed by NIC members in journal entries and interviews. Using reflexive thematic analysis (Braun et al., 2023), I identified and refined five themes which arose as individuals motivated their participation: *relational* motives, *self-improvement* motives, *student experience* motives, *influence* motives, and *values to action* motives. During the member-checking process (Brit et al., 2016), NIC members strongly identified with the *student experience* and *self-improvement* motive, and overall indicated that

the five themes encompassed and aptly described their reasonings for NIC participation. Identification of these themes led to the following conclusions:

- Undergraduate mathematics community members see equity-oriented reform work as an opportunity for personal and professional growth, value its collective nature, and seek to better student experiences.
- Motives which center enhancing student experiences are often expressed without attention to the differential ways in which students experience undergraduate mathematics; that is, using a *for all* lens which can impede progress toward equity in mathematics education (Martin, 2003).
- The majority of motives for engagement in such reform work center self-interests, such as strengthening professional relationships or learning new skills.
- While working toward self-interested motives could positively impact the experiences of marginalized students, there exists a need to grow beyond self-interest in order to make transformative change (Idahosa & Vincent, 2019).

Connecting to Idahosa and Vincent's (2019) work, I make the recommendation that supporting folks to see beyond self-interest involves supporting them in becoming *critically engaged:* disrupting their own comfort, apprehending the natural as strange, imagining a different order of things, and engaging in regular reflexivity. In the ACT UP Math setting, the research team is well positioned to understand how to weave activities which promote critical engagement into our interactions with the NIC members as we endeavor to support them in becoming agents of transformative and equity-oriented change.

Further, I highlight that the results of the first analysis support my assertion in Chapter 3 that the binary established through classification of motives as intrinsic or extrinsic is insufficient

for deeply understanding the complex motives of human practitioners. For example, we can consider the *relational* motive in which undergraduate mathematics community members expressed a desire to strengthen existing personal and professional relationships and develop new relationships. This motive can have both traditionally intrinsic components (for example, a desire to feel a sense of belonging, or a desire to feel connected to others), and traditionally extrinsic components (for example, building up a more robust professional network, or being outwardly seen as someone engaging in this work). Consider Olivia's (TU) expressed relational motive of wanting to establish ACT UP Math participants as "leaders and resources" within the department. Establishing oneself (or a group of folks) as a leader and resource could have both intrinsic value in professional fulfillment, while also having extrinsic value in social positioning. To classify such a motive as intrinsic or extrinsic would inherently erase some dimension of its complexity, and thus I consider the findings of the first investigation as further troubling the binary put forth by the intrinsic and extrinsic classification scheme.

The second analysis centered on a particular institution (KU) as the NIC collaboratively developed a shared object for their NIC activity. Using CHAT as a conceptual framework, I engaged in a mini-ethnographic case study analysis to understand what *rules*, *communities, divisions of labor,* and *artifacts* mediated the *subjects'* (NIC members') development of a shared *object* in the context of their conversation. This analysis resulted in several conclusions:

- Instructors' personal experiences and perceptions of students' experiences were particularly prevalent artifacts which guided the development of the shared object, and brought both affordances and limitations to the group's progress.
- The contributions of the NIC's two undergraduate students were infrequent and often positioned as providing context for instructors' observations and ideas.

- Data sources were not explicit mediating artifacts in this object development, despite the ACT UP Math project's explicit aim to be data-driven in reform.
- In the absence of data and with the prevalence of instructor perspectives, paternalism and identity neutrality were frequently reflected within the NIC's discussion.

With the knowledge that dimensions of CHAT are never isolated from one another, this analysis yielded a deeper understanding of how the NIC came to their shared object, and the discussion turned a critical eye toward the dominance of instructor perspectives. I recommend, building upon the *antidotes* to paternalism provided by Jones and Okun (2001), that it is not enough for reform efforts to position *students as experts on their own experiences* through bringing undergraduates into decision-making spaces and foundationally considering data sources. There exists a further need to position *instructors as novices on student experiences*, such that student experiences are not dismissed as lacking knowledge or authority in the context of shaping reform.

6.2: Connecting the Two Investigations

These two investigations considered the CHAT concept of *object* within two different settings: individual reflection and collective generation. Within these two settings, we can begin to see connections between the two analyses that yield insight into how they might be linked. An initial prevalent similarity is the presence of identity neutrality in both individually expressed motives and collective goal generation. We can safely assume that all NIC members were aware that ACT UP Math was designed to be an equity-oriented project; however, the ways in which students experience undergraduate mathematics differentially based upon social identity markers was not often considered in individual motives across the three institutions and was not mentioned at all in KU's discussion which led to their collective object. I view both as further

evidence of identity neutrality in undergraduate mathematics discourse (Hagman et al., 2024; McNiell et al., 2022). Multiple KU NIC members appeared aware of differential experiences through their individual motives expressed in journal entries and interviews, but did not bring this awareness into the collaborative discussion space. Because of this, I consider the notion of identity neutrality as something which may extend beyond an ideology which is merely prevalent in discourse within undergraduate mathematics; I posit instead that it may be a collective *norm* in collaborative undergraduate mathematics spaces.

The pervasiveness of identity neutrality in discussions of reform could also be due to the political climate surrounding KU; as elaborated upon in Section 5.1, KU exists in a particularly volatile state with regard to attitudes toward DEI work. Understanding how to best support folks in these types of environments to continually make progress toward equity for their undergraduate mathematics students is an important line of future work, and one the ACT UP Math research team is presently discussing. As more US states pass legislation limiting the ways in which issues of DEI can be addressed (Chronicle for Higher Education, 2024), scholarship which works to understand how equity work continues in the face of such limitations is particularly important. One such way of continuing this work could be adopting an identity neutral lens for safety. However, progress toward equity *does* necessitate an attention to the differential impacts of students' social identities on their learning; understanding how undergraduate mathematics community members navigate this politicization of reform work may necessitate building on work which discusses modes of resistance in higher education (e.g. Motts et al., 2015; Preston & Aslett, 2014), or how folks in undergraduate mathematics departments "fly under the radar" to continue DEI efforts within politically hostile environments (Gutiérrez, 2016).

Other possible connections between individual motives and a collectively generated object were less explicit. A preliminary analysis which motivated my focus on collective object generation following an understanding of individual motives seemed to indicate that this connection would be more explicit. Near the end of Summer 2023, I considered the motives put forth by the Spring 2023 KU NIC and the Spring 2023 AU NIC alongside the goals that these NICs had set forth for themselves for the Fall 2023 semester. The motives expressed by the Spring 2023 KU NIC members were predominantly *student experience* and *influence* motives, and their goal for Fall 2023–to collect additional data from students and change NIC membership to include undergraduate and graduate students–felt related to this prioritization of shifting student experiences. The Spring 2023 AU NIC, on the other hand, expressed mostly *self-improvement* motives in their individual journals and interviews. Their goal for Fall 2023 was to target pedagogical shifts in individual classrooms as a site for equity-oriented change, which reflects *self-improvement* motives' encompassing of professional growth.

However, such parallels are not so easily discerned in my analyses of the KU NIC's collective object generation in the Fall 2023 semester. As articulated in Section 4.2, we see that the five themes are relatively evenly distributed within the Fall 2023 KU NIC, with the exception of the *self-improvement* motive, which occurred less among KU NIC members. Their developed object –interrogating rigor and volume of work within calculus courses at KU– doesn't immediately reflect a particular theme found in the individual motives. This does *not* mean that individual motives do not impact collective goal generation. Studies like Miettinen (2005) and Crandall and Schaller (2013) very clearly assert that the interests of individuals *do* shape the progress of the communities with which they engage. However, searching for these connections

within collective object generation did not prove fruitful for establishing an explicit connection in the context of the Fall 2023 KU NIC mini-ethnographic case study.

Table 13. Fall 2023 KU NIC members alongside which themes they expressed as motivating their participation in journal entries and interviews (shaded boxes).

Pseudonym	**Relational**	**Self-Improvement**	**Student Experience**	**Influence**	**Values-to-Action**
Tiersa					
Skylar					
Anna					
Senna					
Kiara					
Parker					
Ricardo					
Timothy					

Digging a little deeper, we see that a connection between individuals' expressed motives and the collective object may come from understanding how they *engage in* developing a collective object. For example, in considering the paternalism present in the KU NIC's collective object generation (see Section 5.3), we observe that statements exemplifying paternalism principally came from Parker and Senna. Looking at the individual motives expressed by the Fall 2023 KU NIC members in Table 13, it is interesting to observe that Parker and Senna, as instructors, both did not express *self-improvement* motives in their individual reflections. In Section 5.3, I assert that an important dimension to disrupting paternalism in collaborative reform is for instructors to position themselves as *novices*; perhaps coming into the space of reform without recognizing their own need or desire to grow (as is done in a *self-improvement* motive) results in less consideration of themselves as folks who *need to* learn and grow through

the foundational consideration of students' perspectives. Ricardo also did not express a *self-improvement* motive, nor did he express paternalistic perspectives, indicating that this connection between paternalistic approaches and the absence of a self-improvement motive may be more relevant for individuals whose professional identity encompasses an instructional role.

I want to explicitly acknowledge that I do not draw this connection to indicate that individuals with certain motives (or lacking certain motives) should *not* come into equity work. Battey and colleagues (in Crespo et al., 2022) caution against making such statements:

> Analogous to how math is used as a gatekeeper to determine who is engaged in what 'counts' as disciplinary work in the field, such logics of gatekeeping can happen in circles amongst equity-oriented researchers. (p. 89)

The goal in being critical of motives and their impacts on how one engages with equity work is not to prevent folks from participating in reform, as would be antithetical to Larnell's (2023) call to make DEI efforts a shared responsibility within undergraduate mathematics education. Instead, I propose that individual motives provide indicators of how individuals might engage in equity work. Supporting Parker and Senna to see themselves as *novices* with regard to students' experiences could be a response to our knowledge that they didn't come into the reform space with *self-improvement* motives, and thus supporting them to intentionally reflect on what they can learn from their participation–in particular, from interacting with undergraduate students and student data–could be a step toward countering paternalism within their perspectives. It is also interesting to think about this with regard to Skylar, one of the NIC leaders, who did not express a *student experience* motive in her individual reflections. As one of KU's calculus instructors, Skylar frequently positions herself in NIC meetings as deeply responsible for how students are experiencing mathematics at KU, and often does so through recognition of areas in which *she*

herself could improve. As the KU NIC progressed in their work, they also decided to focus on her class specifically as a site for change. Perhaps the absence of a *student experience* motive is reflective of a heightened feeling of personal responsibility for creating more equitable environments at KU, stemming from motives for participation purely reflecting the themes which would center herself. Further theorizing could come from more focused scholarly work on how individuals' motives shape how they interact and contribute to collaborative reform environments, rather than how those motives may link to a collectively developed object, as was attempted within this dissertation.

6.3: Opportunities for Future Work

In the section above on "Connecting the Two Investigations", I elaborated on connections I saw between the individual and collective notion of *object,* or motive. Notably, within these connections, the two dimensions were kept separate; while I theorized about relationships between them, I was positioning them and understanding them as separate aspects of the phenomena of NIC activity. This was an intentional choice in my study design. By better understanding the landscape of individual motives and collectively generated objects separately, I figured that drawing connections between the two would come naturally once I had dissected both dimensions. However, as seen above, this was not the case. As individual motives expressed in journals and interviews were not explicitly brought in to guide collective object generation, understanding how the two connect took on a more nuanced approach, necessitating the consideration of data beyond that which was analyzed in the two investigations of this dissertation. This would mean a longer-term investigation; Dowd and Liera (2018) write that "the empirical gap in the evidence concerning individual conceptual…change in contrast to broad organizational change is due in part to the relatively short duration…of most case studies"

(p. 8). Opportunities for analytic lenses to be applied to longer term investigations in future work are elaborated upon below.

Therefore, I find it fruitful to begin speculating on what kind of analytical lens might have more seamlessly provided a cohesive synthesis of connections between individual and collective motives within reform–one in which they are studied *within the same analysis* rather than in two separate analyses between which connections can be speculated. I first propose an adaptation of Rasmussen et al.'s (2015) interpretive framework for individual and collective mathematical activity. In an attempt to synthesize Rasmussen et al.'s (2015) expanded interpretive framework for linking individual and collective activity with Reinholz et al.'s (2020) call for greater research focused on change in mathematics departments, I propose an adaptation to begin analyzing links between individual and collective activity with regards to creating and undertaking equity reform within the mathematics department (Figure 13). Such an adaptation opens methodological possibilities as well, such as the detailed conversational analysis conducted by Rasmussen and colleagues (2024), when studying processes of reform in undergraduate mathematics departments. The analyses in this dissertation do not align well with this adapted framework, and thus are not necessarily appropriate to use as examples of how one might view data in equity-oriented reform environments through this lens. However, it could be interesting to conduct an ethnography rooted in this adapted framework to more closely connect the individual and collective (social) dimensions of reform activity in undergraduate mathematics departments.

Social Perspective	**Individual Perspective**
Department social norms	Beliefs about own role, others' roles, and the general nature of mathematics department

Sociomathematical norms		Mathematical beliefs and values	
Disciplinary practices	Department practices and policies	Participation in reform	Conceptions of equity
What is the progress of the department/the undergraduate mathematics community more broadly?	What are the normative ways of reasoning that emerge in a particular group focused on reform?	How do individual community members contribute to the reform progress that occurs across small group and whole class settings?	What conceptions do individual community members bring to bear in reform-oriented discussion and activities?

Figure 13. An adaptation of Rasmussen and colleagues' (2015) expanded interpretative framework to understand individual and collective reform activity.

Further, CHAT analyses (Engeström, 1987; 2001; Núñez, 2021) are a way to link individual and collective dimensions of activity (Roth & Lee, 2007). CHAT asserts that motives and collective objects iteratively shape each other throughout the course of an activity (Miettinen, 2005). Considering the activity of the KU NIC in a longer-term CHAT analysis, in which the dimensions of CHAT are elaborated upon over the duration of the Fall 2023 KU NIC's work rather than drawn from one particular meeting, could provide insight into this iterative shaping happening between collective objects and individual motives. The example considered in Section 5.3, in which I highlight tensions felt by KU NIC members around the lack of action in their shared object, could provide the basis for such a CHAT analysis. The rule they developed of needing to *take collective action* is likely connected to the prevalence of *influence* motives among NIC members; that is, all NIC members apart from one shared a desire to be a part of change in policy or practice at KU. A contradiction then arose when their shared object does not necessarily orient itself toward such change–this contradiction supports the disconnect between the rule of *take collective action* and their shared object around investigating rigor, and would

therefore be a foundation for a CHAT analysis which explicitly connects these individual and collective dimensions of activity within one investigation.

Even more comprehensive may be bringing an analysis of the broader ACT UP Math project activity system to the next generation of CHAT: the third generation (Figure 14), which is particularly well-poised for studying equity-oriented organizational change in higher education (Núñez, 2021). As a result of these dissertation analyses, we as the ACT UP Math research team have already begun conversations around disconnects and contradictions that could exist within the overarching *activity system* of ACT UP Math, which compares the KU NICs' activity and our own as a research team. One contradiction we notices was that, while we shared the overall object of "enacting critical, transformative change" (in position "Object_3" in Figure 14), the ways in which each activity group was conceptualizing the rule of *be critical* was starkly different in its attendance to identity. As a research team, we considered criticality to necessarily incorporate an attendance to differential student experiences in accordance with social identity markers. As elaborated on in Chapter 5, however, this was not a part of the KU NIC's understanding of what it meant to *be critical*. They instead were considering criticality to be purely an attendance to systems and structures. Thus, tension was created from the identity-neutral nature of their shared object (interrogating rigor) and our object of supporting them in critical, transformative change, based upon a difference in what it meant to adhere to the rule of being critical.

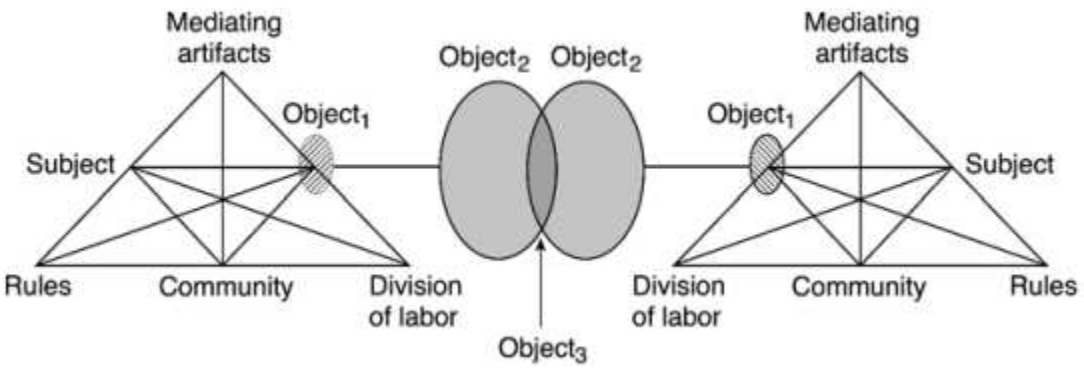


Figure 14. Third-generation CHAT, taken from Engeström (2001).

In line with the dynamic, transformative nature of CHAT analyses (Núñez, 2021), these observations resulted in a shift to our approach as a research team. As a result of identifying these contradictions, we revisited definitions of criticality with the KU NIC, pulling together NIC members' own definitions they had expressed in prior journal entries, and asking them to refine those definitions collectively. We also provided our own input on what we saw as important to criticality, inviting them to incorporate identity within these definitions and consider the ways in which their current goal as a NIC either aligned or did not align with *being critical,* according to their definition of criticality. This provided us as a research team with greater clarity around how the NIC was conceptualizing this rule, and better understanding of the tensions we felt when assessing the NIC's developed object through our own lens of criticality.

This was effectively an informal third-generation CHAT analysis. Roth and Lee (2007) point out that one benefit of CHAT analyses is their ability to provide direction for productive shifts in real time. Another example of a real-time observation through a CHAT lens was our awareness that the research team was operating with a rule of *be data-driven*, but that this rule did not inform the KU NIC's collective object (see Section 5.3 for details). Identifying contradictions, such as that between the research team and the KU NIC's understandings of the *be critical* rule or the (non)existence of a rule of *be data-driven*, allowed us to productively

address consequential tensions within ACT UP Math as a broader activity system. At the time of writing this dissertation, we do not yet have data to make claims about the effectiveness of these efforts to address such tensions. However, I note that CHAT is an iterative process; in considering what tensions or contradictions continue to arise within this work, there will always be opportunity for re-mediation dependent upon what we observe as a result of our efforts to support the NIC in creating transformative change (Dowd & Liera, 2018). As such, future work might formalize such third-generation CHAT analyses, yielding insight into how to respond to tensions in reform work, particularly in activity systems of equity-oriented research practice partnerships.

In summary, the two investigations highlighted in this dissertation provided independently valuable contributions to scholarship on what motivates individuals to participate in equity-oriented reform efforts in undergraduate mathematics education, and how undergraduate mathematics community members come together to develop a shared object for their reform work. Identity neutrality proved a dominant component of the discourse in both individual reflections and collaborative conversations around objects, reflecting prior work on its prevalence within undergraduate mathematics (McNeill et al., 2022). While preliminary informal analyses from the Spring 2023 semester suggested a strong link between individually expressed motives of NIC members and the shared object for their NIC activity, this link was more difficult to parse in the Fall 2023 formal analysis conducted, suggesting that considering the conversational process of shared object development was not necessarily a useful unit of analysis for investigating this link specifically. Analytical tools which bring together the individual and collective dimensions of activity in *one* analysis, such as an adaptation of Rassmussen and colleagues' (2015) interpretive framework or formal CHAT analyses (Núñez,

2021) could serve to provide a greater explicit understanding of this link between individual motives and collectively generated objects.

Positioning equity in undergraduate mathematics education as a shared responsibility necessitates calling in undergraduate community members to participate in collaborative, critical, and transformative change. The individual motives which mathematics students, faculty, and administrators express as motivating their participation in such environments incorporate desires to strengthen and maintain relationships, grow in their knowledge of equity and as practitioners of undergraduate mathematics education, improve students' experiences with mathematics, influence practice and policy, and enact personal or professional values of the importance of DEI or of mathematics as a discipline. The self-interested nature of many of these motives necessitates critical thought, and a need to see beyond self-interest to promote transformative change through critical engagement (Idahosa & Vincent, 2019). These motives are brought into collaborative spaces in which collective objects are constructed, and can influence how such collective objects are shaped. Identity neutrality and paternalism remain prevalent obstacles to transformative equity reform in these contexts. In conjunction with positioning *students as experts*, there exists a need for instructors to position themselves as *novices* in the context of reform. Supporting growth in this direction requires supporting instructors in moving past defensiveness to recognize the centrality of students' perspectives to reform work, and promoting meaningful engagement with data around differential student experiences. The investigations presented in this dissertation join a body of work envisioning a future in which addressing equity issues in undergraduate mathematics education is a collective responsibility. Through critique, I aim to promote responsible engagement in reform as we work toward greater

equity in experiences and outcomes within undergraduate mathematics, and highlight opportunities through which such work can produce toward critical, transformative change.

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