How Communities of Transformation Support Change Agency

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Introduction

Despite repeated calls and ample funding allotted to transform STEM higher education, initiatives targeted at the course and curriculum levels have not led to pervasive changes in how we educate undergraduate engineering students. In this research paper, we shift the focus from what or how faculty teach, to address how faculty themselves learn to become change agents in driving and sustaining change efforts in engineering education. Existing literature notes that communities of practices (CoP), including faculty learning communities and communities of transformation, are a helpful model for disseminating innovations and addressing challenges in engineering education [1], [2], [3]. Regional, national, and virtual CoPs contribute to STEM higher education reform [3], yet we know little about the specific structures and interactions that define these communities, and how those features are related to the development of faculty members' change agency [4]. To address this gap, we utilize a case study of a cross-institutional CoP dedicated to academic change. Drawing on theories of change from sociological and situated learning perspectives, we analyze the structural features of the community that encourage specific forms of interaction between participants, and how they facilitate the development and exercise of agency toward the goal of changing STEM higher education.

Literature Review

Communities of Practice

Our analysis of a cross-institutional network dedicated to transforming STEM higher education draws upon a rich literature about *communities of practice*. A CoP is defined as a community of individuals who strengthen their practice in a particular domain through regular interaction with each other [5], [6], [7]. Traditional CoPs tend to develop organically and be based within an organization. Many variations of CoPs have emerged in the past decades across different organizational contexts. For example, *professional learning communities* are common strategies for improving teaching practices in K-12 education spaces and are typically more highly designed and structured [8]. *Faculty learning communities* are a similar learning space dedicated to curricular and pedagogical shifts in higher education [9].

Within the broad range of CoPs, we situate our case study as an example of a *community of transformation* (CoT) [10]. This variation is a unique form that differs from traditional CoPs in its focus on transforming participants' consciousness and radically reimagining the status quo as opposed to improving upon existing practices. Informed by theories of transformative learning, CoTs "create and foster innovative spaces that envision and embody a new paradigm of practice" [10, p. 853]. CoTs are typically networks that span across multiple institutions and operate in a hybrid in-person and online form. They utilize a moderate degree of structure and are "intentionally designed with organic elements" [10, p. 854]. Through articulating and embodying

a philosophy, and through forming a web of relationships, a CoT supports its members to engage in critical reflection and develop a plan of action to change systems in their institutional contexts.

In this paper, we analyze our case study as an example of a community of transformation and will use this term when referring specifically to this community. However, since CoTs are situated within the scholarly lineage of CoPs and share many important features, we also draw upon literature about CoPs more broadly to understand the structures and interactions in this CoT.

Structure, Agency, and Transformation

Why have efforts to create pervasive changes in STEM higher education been unsuccessful, despite the resources allocated to the cause [11], [12]? Resources alone have proven not to be sufficient in creating and sustaining change at a higher level, especially in the absence of interpersonal networks and ongoing support structures that help faculty members set realistic expectations and make informed decisions about innovation adoption [12]. Therefore, foregrounding resources in theories of change do little to explain how faculty members utilize those resources at varying degrees of success, and the role of collective action in shaping capacity for transformation. To address changemaking from within existing structures, we explore how communities of practice can create new possibilities for transformation within institutions of higher education. Specifically, we focus on exploring how academic changemakers, who come together in a community of transformation, exercise agency to create systemic change.

Examinations of agency in engineering education have predominantly focused on student agency; studies of faculty agency have remained limited [13]. Moreover, no study to our knowledge has addressed how collective contexts such as CoTs support faculty agency toward systemic change. Thus, an examination of organizational and structural features that support changemaking efforts is necessary [13]. This is an important gap, as opportunities for deliberation and sensemaking of the self, the situation, and existing resources support changemaking capabilities [14], and CoTs provide an ideal organizational context for faculty to engage in critical reflections that support agentic perspective and action.

Faculty exercise agency when they take specific action toward their personal or collective goals for systemic change [15], [14]. The exercise of agency refers both to agentic perspective, that is, reflections on how specific actions would impact goals related to engineering education change, and agentic action, which is taking steps toward the achievement of those goals [14]. Past research has explored the connection of these components to show that agentic perspective has a large impact on how individuals take agentic action [15].

Building on these conceptualizations, we introduce Sewell's [16] theory of change to engineering education to examine how CoTs provide structural opportunities that support faculty

agency in their goals toward systemic change. To build the possibility of change within a system, and to restore agency to changemakers, we utilize Sewell's interrelated theories of structure and agency. First, structure refers to cultural schemas (mental structures) and resources, which are unevenly distributed across space and social actors [16]. For example, experienced changemakers who have achieved institutionalizing a pilot project would have a unique know-how of change sustainability (cultural schema). There may also be institutional resources available on one's campus (e.g., pedagogical innovations and technologies), that remain inaccessible to other departments or units due to insularity. Second, agency is the creative capacity to reinterpret and mobilize resources and schemas (i.e., structure), for purposes outside the original context in which they were created. For example, inviting experienced changemakers from outside the CoT to share their know-how with the community could lead CoT members to expand on this know-how in creative ways and lead to changemaking in additional contexts. Similarly, learning about inter-departmental connections built by some CoT members and how these institutional resources benefitted changemaking could disrupt insularity on other members' campuses and lead to new forms of collaboration. In the context of this paper, we focus on structures in the CoP that facilitate agency as well as the structures within changemakers' institutional contexts.

Social actors' institutional and social positions in a collective organization, including interpersonal relationships, inform their knowledge of existing schemas and resources, and therefore their transformative capacity. By leveraging their knowledge of the structure and existing social relations in creative ways, changemakers can transform their environments. Examining the structural features of a cross-institutional CoP allows us to demonstrate how the community supports its participants' capacity to leverage available resources and schemas to effect change.

Leadership and Facilitation Structures

Leadership and facilitation structures are important facets of a CoP that support the development of change agency for their participants. CoP leadership is a key factor in sustaining CoPs [3]. In particular, scholars note that communities benefit from having designated community members to broker social connections and to invite guests on a regular basis, as these activities are difficult to sustain over time [1]. CoP leadership may invite successful changemakers in STEM higher education to community meetings and facilitate conversations and connections between the community and external actors who have experience in effecting change in their own environments. We would expect this type of leadership to support the exercise of agency, and therefore a community's capacity to make systemic change. When participants build and leverage social connections in STEM higher education, they can exert control over those social relations to build new partnerships to support institutional change, learn about ways to appropriate existing resources in their environment to transform those environments, and extend ways of thinking in support of transformative learning.

How Cross-Institutional CoPs Support Change Diffusion

Cross-institutional CoPs, that is, communities that bring together individuals across different higher education institutions, may be particularly effective at creating systemic changes [1], [3]. Firstly, to transform STEM higher education, individuals need to understand their own institutional context [2]. When a CoP brings together people from different institutions and disciplines, the very structure of the community requires members to articulate their own change context to those unfamiliar to it and make comparisons vis-a-vis other participants' situated experiences [2]. Through those cross-institutional connections, participants would gain a deeper understanding of their own change context, de-familiarize what is taken for granted, and arrive at new possibilities for change.

Secondly, to transform STEM higher education, changemakers need to have effective methods to disseminate innovations [12]. These include pedagogical innovations [1] but may also be relevant to the diffusion of other innovations or changemaking strategies. A CoP that crosses institutional boundaries would operate as a network to diffuse change [3], and provide a viable model for effective dissemination, an expanded external professional network, a collaborator hub, and moral support to sustain the change work [1]. A community comprising actors with connections to a wide range of schemas and resources would facilitate the creative use of those existing structures, offering opportunities for creating change from within those structures [16]. Through their cross-institutional connections, participants would be introduced to new ways of thinking and utilizing existing structures in creative ways.

Data & Methods

To examine how the features and practices of a community of practice contribute to the development of change agency over time, we utilize a case study approach. Case studies provide rich data to study processes that unfold over time within bounded social networks like communities of practice [3]. We examine the exhaustive set of meetings of a cross-institutional community of transformation, spanning three academic years, and identify how features of organizational structure and interactions relate to the unfolding of change-making.

Case

The data for this case study comes from our participatory action research project with the National Science Foundation (NSF) Revolutionizing Engineering Departments (RED) grant recipient teams, funded to design, institutionalize, and sustain revolutionary changes in their home departments or colleges across different higher education institutions. As part of the funding requirement, all teams are multidisciplinary. In addition to the engineering faculty, each team includes at least one social scientist or organizational change expert, engineering education researchers, administrators, and staff. As of early 2024, 30 RED grants at 28 institutions have been funded since 2015. Alongside the change teams, our team (REDPAR) has been funded to conduct research with the change teams and support the teams by facilitating a community of transformation.

The facilitated CoT meetings take place virtually throughout the academic year and bring together the changemakers on a regular basis to discuss change work, the levers and barriers of change, and prompt them to reflect on contextual opportunities and challenges related to changemaking. In addition to facilitating discussions among the participants, the REDPAR leadership delivers change-making related content and resources and invites guests with change expertise or relevant experience to join the meetings to foster connections and transformative learning.

In addition to the virtual meetings, each year, the RED teams come together for an in-person gathering facilitated by REDPAR. While REDPAR does not collect systematic data at the in-person gatherings, the virtual meetings often include change teams' reflections about what they learned or experienced at the in-person gatherings.

The RED meetings bring together teams that have been funded at different times since the launch of the program in 2015. Thus, in addition to offering cross-institutional perspectives, the community also brings together teams that are at different stages of the change process, with different levels of experience with changemaking. The inter-cohort aspect of the community allows us to examine the diffusion of knowledge and practices in the network.

Data Collection & Analysis

We leverage our access to the exhaustive set of meetings to systematically address how transformative learning, development and exercise of change agency take place in a cross-institutional, cross-cohort community of transformation. To that end, we analyzed the total population of the monthly CoT sessions (N=31) from 2017-18, 2018-19, and 2019-20 academic years. All teams that were funded at the time (N=21) from the first four cohorts of the program are represented in the dataset, with members from a mean of 12 teams (min=5; max=17) participating in each of the meetings, alongside the REDPAR leadership, and guest attendees. Seven out of the 31 meetings (23%) featured guest presenters.

At the time of writing, two more cohorts have been funded by the RED program, for a total of 30 teams. We expect the underlying structure of the community meetings and the types of interactions analyzed here to be similar in more recent CoT meetings.

For the analysis, we transcribed and qualitatively analyzed the meetings using Dedoose qualitative data analysis software. Our codebook includes the variety of topics covered at each meeting (e.g., sustainability of change, building strategic partnerships, addressing faculty resistance, dealing with disciplinary differences, indicators of change), organizational features of the CoT (e.g., pedagogical structure of the meetings, REDPAR facilitation techniques, cross-team collaborations and networking), and the teams' own experiences with changemaking (e.g., practicing engineering equity: RED examples, inclusive pedagogies, building relationships with students, active learning classes, a new degree in engineering, getting students to develop inclusive skills and mindsets). We then identified how organizational features and shared

practices and interactions in the community contributed to the development of agency as the changemaking process unfolded over time.

In addition to the codebook, analytical memos were written for each of the meetings. The memos noted the tone and level of engagement at the meetings, the presence of guests, and any new code added to the codebook after the meeting. The memos and the codebook allowed us to examine the findings in relation to theories of change that motivated and guided the research study.

Findings & Discussion

Through this case study analysis, we identify elements of the community structure and how these structures support powerful forms of interaction in the community over time. Figure 1 below describes the key aspects of structure and change agency growth that we found in this study. In the next section, we provide examples demonstrating how these interactions contribute to team members' development and deepening of change agency within an inter-institutional facilitated CoT.

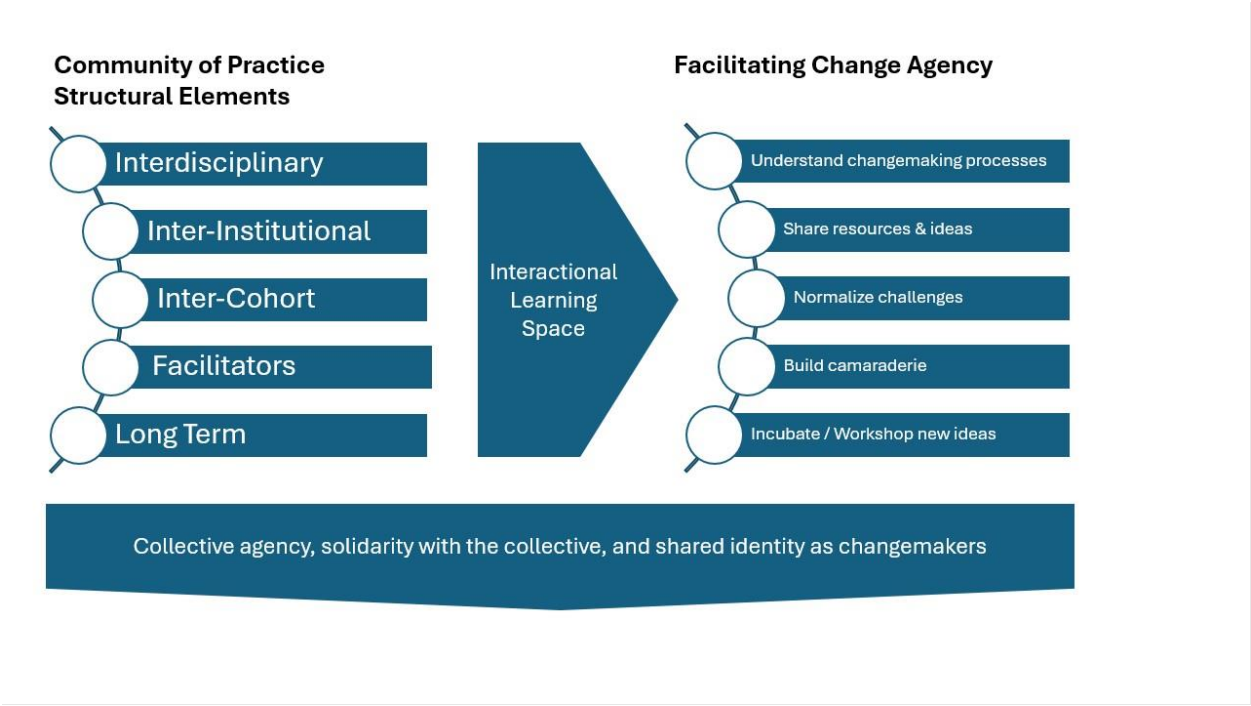

Figure 1. How Structural Elements Support Change Agency in the Community of Practice.

Structures & Interactions

Key structures of the community of transformation create interactional learning spaces for participants. In particular, because the CoT is interdisciplinary, inter-institutional, and inter-

cohort, there is a constant sense of learning from others who are in different contexts and those who have different expertise. For example, the community occasionally supports what we call "role calls" in which individuals in similar roles in their projects meet to discuss issues across institutions and cohorts. This allows sharing about topics that are highly relevant to each person on the role call because of their role in their project, and enables sharing of lessons learned more easily across institutions.

The other key structural characteristic of this CoT that supports participants' development of change agency is that the community is organized by the RED Participatory Action Research personnel who facilitate discussions and encourage critical reflection, iterative learning, and planning for action.

An example of this is when a member of REDPAR said: "I believe that sharing resources is one advantage we have in having this community, I just, I'm just not sure where that sharing might happen. I'd be very happy to facilitate that in some way." The REDPAR team serves as a connective force by creating space for teams to cross-pollinate ideas, experiences, and tools they have developed.

REDPAR also continually encourages CoT members to engage in reflection and does not assume that they know the answers to the questions they pose. The following example is a battery of questions asked in one of the meetings that shows the multi-pronged and multifaceted approach taken to support reflection and learning.

> REDPAR: What challenge(s) have you encountered in your project? How are challenges different from Year 1 to Year 2/3/4? What resources (people, materials, etc.) have you used to address the challenge? What advice would you give to another team encountering the same challenge? Are there some challenges that are not resolvable? How do you know when to stop trying and move on?

These forms of facilitation by REDPAR staff invite team members to reflect critically on their changemaking experiences and develop plans for the future. The questions are also posed in ways that center participants' expertise and position them as knowledgeable mentors to others in the network. REDPAR facilitation provides opportunities for dedicated reflection time and sustained dialogue within the CoT. Network leaders intentionally incorporate a variety of interactions over time, including groupings by RED role, by cohort, by team, by random assignment, and more.

This central feature of the RED CoT aligns with the focus on critical reflection and action planning in other communities of transformation. As we describe below, the reflective and generative nature of RED CoT gatherings also supports participants to engage in the creative work of strengthening and exercising agency as conceptualized by Sewell [16].

Deepening Change Agency

Overall, these structures of the CoT function together to encourage specific forms of interaction that facilitate participants' development and deepening of change agency. Certain types of interactions support the growth of members' capacity to understand and mobilize resources and information for new purposes.

As mentioned in the methods section, seven of the 31 meetings (23%) had guest speakers who were invited by REDPAR. These guest speakers share their expertise and changemaking experiences with the community, spanning areas such as increasing dissemination impact, propagating innovations, sustaining changes through institutionalization, and addressing power differentials within academia in general and change teams in particular. By facilitating connections with guests with relevant experiences and areas of expertise, the RED CoT helps to expand team members' understanding of changemaking processes and their ability to engage effectively as changemakers.

The inter-institutional structure of the CoT enables teams to share strategic practices that have been pivotal in their efforts to transform their institutions. For example, team members offer ideas to other teams about partnerships and resources that they have found helpful, so that other schools might also take advantage of similar opportunities.

> Sch 5 Eng Ed Project Manager: I strongly recommend reaching out to the: English department, Physics department, Chemistry department, and especially the Math department to discuss the needs of your program and any issues or challenges you see. They are often very open and willing to help and discuss!

As demonstrated by this quote, team members in the CoP offer guidance to their peers about identifying relevant resources and reaching out to likely allies in their institutions. Becoming more conscious of potential strategic partnerships, such as with other departments and centers on campus, is one way participants can build their influence as changemakers.

Inter-institutional and inter-cohort learning also takes place through attunement to shared experiences in team members' journeys of transformative learning and changemaking. In the RED meetings, people regularly check in with each other about where they are in the change process. This enables emotional support and camaraderie around similar issues happening across schools from different cohorts.

> Sch 1 Ed Rsch: What year are you each in your grant?
> Sch 2 Ed Rsch: Going into year 3.
> Sch 1 Ed Rsch: That's good to hear, we have similar conversations at Sch 1 even though we're in year 3 right now and sometimes it's like, we've gone this long and we're having this conversation. It's nice to hear it's happening elsewhere.

This excerpt demonstrates how team members find reassurance through comparing experiences with others because it normalizes the challenges they are encountering and helps them recognize that they are not alone. In addition to noting parallel experiences, network members also often learn from their peers about new approaches that could be relevant in their own change projects.

> Sch 3 Sr Personnel 1: There were several groups that we made notes on learning from previous years…[very quiet] curriculum change, what works and what doesn't…peer mentoring…we saw some things while we were there that other people were doing that were interesting that we would like to hear more about.

Through peer-to-peer learning, team members identify and leverage changemaking strategies that other teams have implemented, thus expanding the possibilities for their systemic transformation work. In this way, the distributed inter-institutional and inter-cohort structure of the CoT, when combined with intentional facilitation of both online and in-person gatherings, contributes to the effective diffusion of insights across teams that results in greater agency at the individual, team, and network levels.

Team members often express gratitude for these opportunities for idea-sharing that contribute to more powerful transformation work:

> Sch 2 Ed Rsch 2: I really appreciated the breakout session. I learned [at the in-person gathering] that I appreciate any opportunity to share the ideas we have. A lot of us have come up with innovative new practices and technology and don't have enough time to transfer that technology. It's great that we can then exchange this info and others can adapt it… actually establish meetings to transfer ideas… I appreciate any time we get for moving technology from one context to another. And thank you all.

Another example of this is the following conversation between participants from two different teams:

> Sch 1 Ed Rsch: And Sch 2 Ed Rsch, my background is in bio-engineering and I'm really [excited] to hear about what you are doing. I tried to implement a bio-engineering module into a material sciences class here at Sch 1, regarding the ethics and social justice concepts that come into play. Once we get this initial paper written for *Frontiers in Education*, I'd love to share that with you."
>
> Sch 2 Ed Rsch: I'd love that. We might need to have you present at one of our RED meetings.

As indicated by these quotes, team members appreciate having dedicated time and space to share new approaches they have developed in their RED projects and hear about the innovations generated by other teams. Gaining inspiration through learning about successful strategies they could adapt to their own context strengthens the change agency of team members. At the same time, the movement of practices and technologies across different institutional contexts reflects a form of collective agency that enables broader transformative impact and overcomes the siloing of knowledge within particular institutions. Unlike traditional one-time workshops, which are limited in the breadth and depth of what can be covered, the regular meetings of the RED CoT address the need to disseminate innovations to the broader community by establishing communication pathways across institutions [1].

Team members recognize the power of these opportunities for cross-pollination and advocate for even more engagement in these diffusion processes:

> Sch 4 Co-PI / Ed Rsch: Or if not discipline specific, it could be strategy specific. We're already comparing and contrasting what we are doing—we could dig into this more so that we can learn more in-depth from each other. If there are activities in different projects that really complement each other, whether research or curriculum activities where we can learn. Keep digging into that, so that we're not waiting until there is an in-depth paper at the end of the project.

This excerpt indicates team members' desire for additional time dedicated to in-depth learning across teams. The expertise of other teams in the network is recognized as an important resource that could strengthen their own approaches. This speaker specifically mentions the benefit of sharing insights while the transformations were still actively in progress, as opposed to waiting to share polished final products. In these ways, the CoT serves as an incubator and supportive space for the workshopping of changemaking efforts. This theme resonates with Kezar, Gehrke, and Bernstein-Sierra's [10] investigation of communities of transformation, which highlights how networks of multiple institutions support participants to move beyond status quo practices. They do so by calling into question entrenched assumptions, providing examples of how change can take place similarly or differently in particular contexts, and cultivating an affirming social and intellectual environment for creative reimagining. Kezar, Gehrke, and Bernstein-Sierra describe how distributed communities "can support people in isolated locations where the environment was bound by status-quo practices" [10, p. 854].

The inter-cohort aspect of the community also resonates with the intergenerational transmission idea in the diffusion of social movements literature. Communities that bring together people with different relationships to change or who are at different points in their change process support the sustenance of the movement and the transmission of ideas and practices between "generations" [17].

Relatedly, the structural quality of sustained interaction and critical reflection within a social and intellectual community enables participants to develop a deeper understanding of how change processes unfold over time. Regular check-ins among participants who are at different points in their changemaking processes are a significant source of insights.

> Sch 1 Sr Personnel: I'll be curious to talk to you in two years, and how things progressed and lessons learned, since it's early. The whole thing with rewards and incentives and the development model is very intriguing. I'd be curious to read your papers as you go along.

The CoT supports teams to build and maintain relationships over multiple years as opposed to one-off encounters. This long-term commitment to the community structure benefits changemakers by allowing them to observe how different teams progress through their transformation efforts. These peer learning opportunities deepen team members' change agency

by providing different examples of how change can shift and adapt within specific institutional contexts.

Through sustained interactions and learning, participants in the CoT build a sense of shared identity as changemakers in addition to their identities as members of specific disciplines or institutions. This shared affiliation is exemplified in team members' organic coordination of in-person site visits to deepen their learning and strengthen their relationships:

> Sch 4 Sr Personnel 4: I think visiting each other, if a group visits the school, it gives not only a shared experience but also national credibility to the project. Our colleagues often think we are alone, so visiting shows that we are part of a larger cohort.

This quote demonstrates team members' desire to continue learning from their peers in the network through shared experiences, as well as the cultivation of solidarity with other teams and with the broader community of transformation. They intentionally and creatively leverage the network to move beyond isolation within their institution, increase the credibility of their transformative work, and build power by visibly identifying as part of a larger collective.

Similarly, team members' shared identity gives rise to large-scale strategizing and planning for action across the network:

> Sch 2 Ed Rsch: This could be an impact that this group has, getting faculty to understand the importance of integrating DEI into their curriculum. Faculty don't see that. If this group could have the impact of reframing that, of integrating those concepts into what we teach, how we teach, the textbooks we use, I think that could be a huge impact of this group.

This team member proposes an ambitious project for the CoT to take on together – showing faculty members the importance of integrating DEI throughout their practices. This vision reflects a strong sense of agency and a desire to enact change on a larger scale beyond their own institution.

In summary, the structure and interactions within the RED CoT promote participants' transformative learning journeys and development of agency as changemakers. This community supports team members to exercise agency to create systemic change from within existing structures and to revolutionize STEM higher education.

Conclusion

Information is lacking on how education transformation efforts are informed by social networks, interactions, and flows of resources between individuals in those networks [4]. Communities of practice, including communities of transformation, are frequently leveraged as a strategy for implementing shifts in educational practices and policies. Though CoPs are a well-recognized approach, there is less understanding of how exactly they contribute to effective changemaking. This article brings attention to the relationships between people in a community of

transformation and describes how the specific structural features and social interactions in the group build team members' change agency, including agentic perspective and agentic action.

The structure of the CoT being inter-cohort and inter-institutional is continually referenced by members of the RED community as resulting in new information or ideas. This builds on the existing social movements literature on intergenerational transmission [17], because the sharing of ideas is a foundation for community and individual growth, supporting the persistence of the community. The engagement of REDPAR as leaders of the CoT is also a structural factor which community members describe as helping them learn and figure out answers to challenges in ways that are supported but independent, thereby helping to sustain the work [3].

The interactions between individuals in the RED CoT contribute to change agency and changemaking by creating new awareness of possible resource flows and creating a network through which members can build their social capital [4]. Participants practice articulating their own experiences with others who may not be familiar with their organizational or departmental context. They also learn through exposure to a variety of similar but distinct changemaking experiences, which can provide new insights about their own transformative efforts. Through these processes, members gain a deeper understanding of and sense of agency within the broader structures in which their change work takes place.

As a case study in an engineering higher education context, this work is just the beginning to better understanding the role of interactions in the development of agency for systemic changemaking in higher education. Also, while we believe that using the meeting transcripts provides an insightful view into the value that CoT members derive from participation, we expect that we could elicit deeper reflections on this topic through interviews or focus groups with community members.

In this paper, we identified the key structural features of a community of transformation that facilitate changemaking in STEM higher education and illustrated how these features support its members' transformative capacity. To guide our analyses, we brought together theories of change from sociological and situated learning perspectives and the rich literatures about communities of practice. We highlighted what it is about this CoT that allows interactions and transformative learning toward the community's overarching goal of revolutionizing STEM higher education. This analysis can contribute to the intentional designing and sustaining of current and future CoTs that seek to reimagine and reshape educational systems.

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