

Re-envisioning a Value Framework for Examining Transformational Communities of Practice in Mathematics Education

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Communities of practice (CoPs) provide a structure that allows individuals with a common goal or purpose to come together to engage in collective learning (Wenger-Trayner & Wenger-Trayner, 2015). The COMMunity for Mathematics Inquiry in Teaching (COMMIT) Network was developed to support regional Math CoPs, called COMMITs, composed of undergraduate mathematics faculty interested in using active learning and inquiry teaching approaches in their courses. For the past three years, we have utilized the value framework, presented by Wenger et al. (2011), to better understand the layers of value faculty experience as they engage in COMMITs and the broader network. In doing so, we have identified modifications to the original model from Wenger et al. that may further interrogate and articulate the layers of value that can be used to help advance and sustain CoPs longterm. We present our theoretical adaptation in the following report.

Keywords: Community of Practice, STEM Faculty, Theories of Change, Value Creation Framework

In recent years, mathematics faculty at institutions of higher education have begun to focus on the use of evidence-based teaching practices, such as active learning and teaching with inquiry, to help support undergraduate student success. Despite mounting research that backs the use of such practices (e.g., Chen & Yang, 2019, Cook-Sather et al., 2016; Freeman et al., 2014; Healey et al., 2014, 2016; Werder & Otis, 2010), many math faculty still engage in traditional lecture style instruction, which is often less effective in supporting student success (Jaworski & Gellert, 2011). Attempting to integrate innovative teaching techniques in isolation can make sustained implementation challenging (Banta, 2003), therefore communities of practice (CoPs) offer a pathway to connect like-minded faculty and create a support system for instructional change. CoPs are defined as “groups of people who share a common concern or a passion for something they do and learn how to do it better as they interact regularly” (Wenger-Trayner & Wenger-Trayner, 2015). They help the group to identify common goals, develop and share resources and ideas, and engage in shared learning to foster transformational change.

Our research team is part of a grant funded project focused on supporting regional CoPs of undergraduate mathematics faculty as they attempt to implement active learning and teaching with inquiry strategies into their courses. The project developed the COMMunity for Mathematics Inquiry in Teaching (COMMIT) Network as a way to loosely connect each region to help the regional CoPs (COMMITs) mature and shift toward sustainability. We identified the value creation framework developed by Wenger et al. (2011) as a tool with which to examine the role of the COMMITs and the broader network in supporting faculty members in their efforts to implement instructional innovations in their courses. We have also examined value-add from the COMMIT level through regional leaders, to determine the facets of the COMMITs and the connecting network that best support all participants (including the leaders themselves) in their pursuit of instructional change. Our preliminary findings support the use of the value framework as a mechanism for exploring this work (Gomez Johnson, Jakopovic, von Renesse, 2021; Gomez

Johnson, Jakopovic, Rech et al., 2021). However, through our data analysis we have established several modifications to the original value framework that we hypothesize will more effectively describe the patterns emerging within value-added data at the CoP and network level. In this report, we share our use of the value creation framework, as well as our proposed modifications and the rationale behind the changes.

Teaching with Inquiry and the Role of Communities of Practice

There is an established body of research that shows how active learning and instructor effectiveness can positively impact students' learning, attitudes, and educational experiences (Freeman et al., 2014; De Vlieger et al., 2016; Laursen & et al., 2019). Incorporating active learning teaching strategies in STEM classrooms can impact students' academic success, overall attitude toward content, and their retention rates in STEM courses (Bowen, 2000), as well as lessen the achievement gap for students from historically underrepresented groups in STEM (e.g., people of color, women) (Freeman et al., 2014; Haak et al., 2011; Hrabowski & Henderson 2017; Laursen et al., 2014; Theobald et al., 2020). Active learning classrooms situate students as partners in the learning process with the instructor rather than acting as passive observers (Cook-Sather et al., 2016; Healey et al., 2014, 2016; Werder & Otis, 2010).

A survey by Rassmussen et al. (2019) found that many mathematics departments in institutions of higher education report believing that active learning is “very important” or “somewhat important,” however these beliefs translated to programmatic implementation only 15% of the time. Garnering buy-in from mathematics faculty can be challenging, as active learning practices challenge the historically accepted cultural norms of mathematics teaching. CoPs have the potential to serve as a vehicle for change (Gehrke & Kezar, 2017). Like other areas of social change, this requires disruption to systems that have been historically inequitable and act against and across existing boundaries (Hooks, 1994). For mathematics education, participation in praxis—engagement in reflection, learning, practice, and action—reduces the gap between theory and practice for faculty. In CoP structures, this allows members to defy norms about who belongs in a community or field, what is pursued, how it is organized, and how it works (Drane et al., 2019; Freire, 1968/2000; Hooks, 1994). CoPs can also give a voice to counter-narratives and people who have been historically excluded from stories and spaces (Solórzano & Yosso, 2002). Given the organic nature of CoPs, they transform and evolve at key points in their development or cease to be sustained if they no longer serve a useful purpose to individual members (Stuckey, 2004). For this reason, attention to the value-added aspects of participation at the COMMIT regional and network levels is important to not only examine long-term sustainability impacts, but CoP creation and implementation factors as well.

Theoretical Framework

We established our research design to study the COMMIT Network project as a community-based approach to instructional and institutional change using situated learning theory (Lave & Wenger, 1991; Wenger, 1998) as the theoretical perspective. Rather than focusing solely on the traditional conception of teacher/pupil learning, situated learning theory conceives of learning as something that occurs as individuals engage in CoPs and social networks (Lave & Wenger, 1991). CoPs involve intricate levels of interaction that can make examining the factors leading to the success or failure of these communities a challenging endeavor. The value creation framework positions CoPs within “a dynamic process in which producing and applying knowledge are tightly intertwined and often indistinguishable” (Wenger

et al., 2011, p. 21). As Figure 1 illustrates, the original framework includes five cycles, or layers, of value creation—immediate (in the moment resources, information, connections), potential (for the future), applied (piloted implementation), realized (actualized implementation), and transformative (broad dissemination to others) value. One cycle does not necessarily lead to the next and the importance of the various cycles can differ for different stakeholders and at different points in the life of the CoP. Strategic and enabling value layers attend to the programmatic processes, structures, and ways of evolving and sharing value with others that support these five cycles.

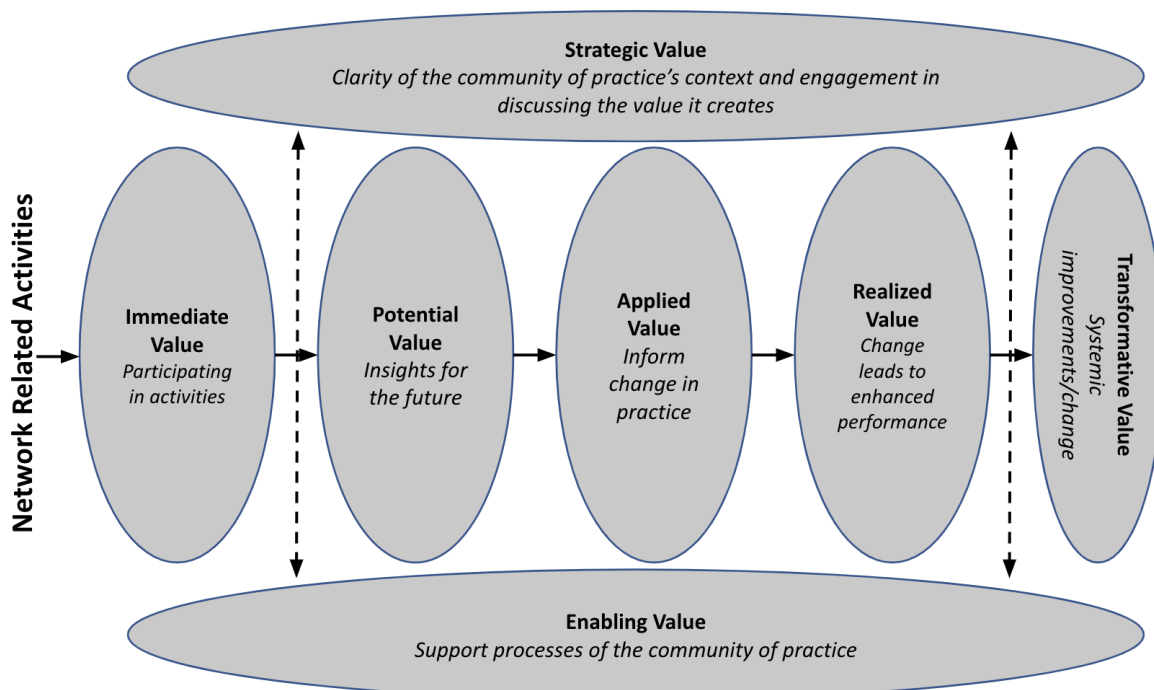


Figure 1. Value creation framework (Wenger et al., 2011).

The value framework in its original form has been utilized in a range of studies around CoPs. For example, Booth and Kellogg (2015) used the value framework specifically to examine value cycles within online CoPs. They identified labels for each type of value as follows: immediate value - productive activities, potential value - knowledge capital, applied value - promising practices, realized value - “return on investment” (i.e. seeing the payoff/benefit of the new knowledge implementation in practice). Clarke et al. (2021) applied the value framework to develop “ground narratives” that allowed them to identify themes within the broader community. In our project, we sought to better understand how the larger network of COMMITs might help to engage stakeholders and expand faculty engagement in the COMMITs. Therefore we adopted the value framework to investigate the experiences of COMMIT participants and leaders and follow the trajectory of the COMMITs themselves, within the context of the larger network. Through our ongoing analyses we gradually began to re-envision the framework. Specifically, we encountered nuances of the value layers emerging as we shifted away from looking at the value of individual participants and toward identifying the value the COMMIT Network afforded regional leaders and their CoPs. In the following sections, we present the findings from our

research that support the need for the hypothesized revision to the value framework at the network level value.

Research Methodology

Data analysis is an ongoing, recursive process that involves the examination, interpretation, and reinterpretation of data and findings (Patton, 2002; Richards, 2009). Design based research positions theory development and refinement within the complex, social contexts within which interventions are examined (Brown, 1992; Tabak 2004). In this section, we report on the findings from our research as a way to illustrate both the need for and envisioning of the hypothesized value framework revisions, as this process is intrinsically embedded into the iterative nature of qualitative research design.

Context

Our research on the COMMIT Network is part of a project funded by a National Science Foundation grant (No.1925188). The authors of this report are researchers on the grant leadership team, initially tasked with gathering and analyzing data to better understand how the COMMIT, supported by the network, could recruit, develop, and retain mathematics faculty use of active learning and inquiry-based teaching practices. During the initial two years of the grant, our research focused on identifying the layers of value that individual COMMIT faculty members self-reported after engaging in COMMIT events and activities. At the end of Year 2 of the grant, we gathered additional data from members of the regional COMMIT leadership teams in an effort to expand our examination of value beyond individual participants to the regional COMMIT and COMMIT Network levels.

Participants and Data Collection

Midway through Year 2 of the project, we surveyed individual CoP participants representing a total of five regional COMMITs in the Math COMMIT Network to gather a first round of data. Participants in this initial data set included responses from 156 faculty members who participated in COMMIT workshops and events in their region. The participants included faculty from a broad range of institution types. Coverage of survey responses represented faculty from K-12 schools (4%), two-year colleges (10%), doctoral granting institutions (18%), and predominantly undergraduate institutions (68%). We created an online survey that included a combination of multiple choice and open-ended follow up questions for participants to identify the value, if any, they found through engaging in COMMIT activities and to what extent they planned to use ideas from these events in their teaching practice.

At the end of Year 2, we used social network analysis to identify leaders within each of the regions (Gomez Johnson et al., 2021b). We then gathered a second phase of data, conducting a total of 19 semi-structured interviews with COMMIT leaders representing eight of the regions in Spring 2021. The interviews focused on the experiences of leaders as individuals, as well as representatives of their regional COMMIT. We collected and analyzed the interview data to help us begin to understand the collective value these CoPs identified as a result of engaging in the COMMIT Network. The analysis of this second data set became the area of focus in our re-imagining of the value framework, as we shifted from talking about the value found by individuals within their group to the value the COMMITs found within the Network. The analysis of this second data set led us to uncover more complex, nuanced sub-layers of value that were not completely captured within the original value framework.

Data Analysis

Our initial analysis of the COMMIT participant surveys involved first deductively coding the open-ended survey prompts for instances where faculty identified any immediate, potential, or transformative value they found by engaging in COMMIT activities. In the second round of coding, we used *a priori* codes where we identified responses that aligned with one of the Four Pillars of inquiry based teaching: 1) students engage deeply with coherent and meaningful mathematical tasks, 2) students collaboratively process mathematical ideas, 3) instructors inquire into student thinking, and 4) instructors foster equity in their design and facilitation choices. (Laursen & Rasmussen, 2019). We determined that these four codes did not completely capture the essence of all participant responses, therefore we conducted a third round of descriptive coding (Miles et al., 2014; Saldaña, 2021) where we identified additional emergent codes in the data. These codes included resource sharing, ideas for technology integration, forms of assessment, evolving beliefs about teaching mathematics, and the usefulness of the COMMIT Network. Participants regularly self-reported finding immediate (in the moment), potential (for future use), and transformative (worth sharing with others) value around these five topics (Gomez Johnson, Jakopovic, von Renesse, 2021). Reflecting on this first set of findings, we determined that, for this data set that focused on the experiences of individual participants, the five layers of value that are described by Wenger et al. (2011) appropriately captured the essence of participant responses.

With the semi-structured COMMIT leader interviews, we began in a similar fashion, coding in a first pass deductively for evidence of the five layers of value. As we coded for transformative value, we identified the need for a distinction between enacted transformative value (dissemination and change that has taken place) and the “potential to transform” (future possibilities to promote teaching with inquiry to the broader community). Therefore, we inductively added a sixth code. This came about due to leaders’ reflections on the value they identified the COMMIT Network providing to their regional COMMITs (versus identifying the value-add for individual participants). At times, leaders shared the ways in which they envisioned taking steps toward transformative action in their COMMIT, but these were phrased as future aspirations and ongoing goals rather than work currently happening within the region (Jakopovic & Gomez Johnson, 2021).

Reframing the Value Creation Framework

As we reflected on this need for an additional code to more accurately capture the essence of value creation at the CoP level, we realized there is a potential connection between the unit being studied (individual participant or COMMIT leader/representative) and the ways in which “transformative value” manifests itself. With faculty participants, their descriptions of “potential value” encompassed the ways in which their participation in the COMMIT Network and regional COMMITs might influence their future, individual teaching practice. Their responses also included ideas as to how they might “transform” teaching by sharing this information with close colleagues or peers. When we analyzed the COMMIT leader interviews, however, they identified opportunities where the Network provided ideas and supports that have the potential to create transformative value within and across COMMITs. For example, one regional leader explained,

I think we have a lot to offer. I think especially because we might be ahead, at least in the idea of [our cultural renaissance], There is a huge focus on respecting [our] culture. Even in the aspect of math, that can be shared in the broader network nationwide and reaching

out to Native American/first nations to collaborate and share ideas. [Our region] has had this ability because of the renaissance of [our] culture happening in the 70s, we are a little further along that we can share, not even inquiry based, but also focus on the place where you are and the people you are teaching.

A leader from a different region shared similar comments with regard to ways their COMMIT had the potential to support other COMMITs, stating, "We have been trying to learn from the others in the network and what they are doing. It is nice to figure out what they are doing. It has been inspiring for us. We hope to contribute like that in the future. I would hope that it's reciprocal." These recurring observations based on our coding and analysis evolved as we made further shifts from studying individuals to COMMIT leaders and have led us to hypothesize a reimaged visualization of the value creation framework, as shown in Figure 2.

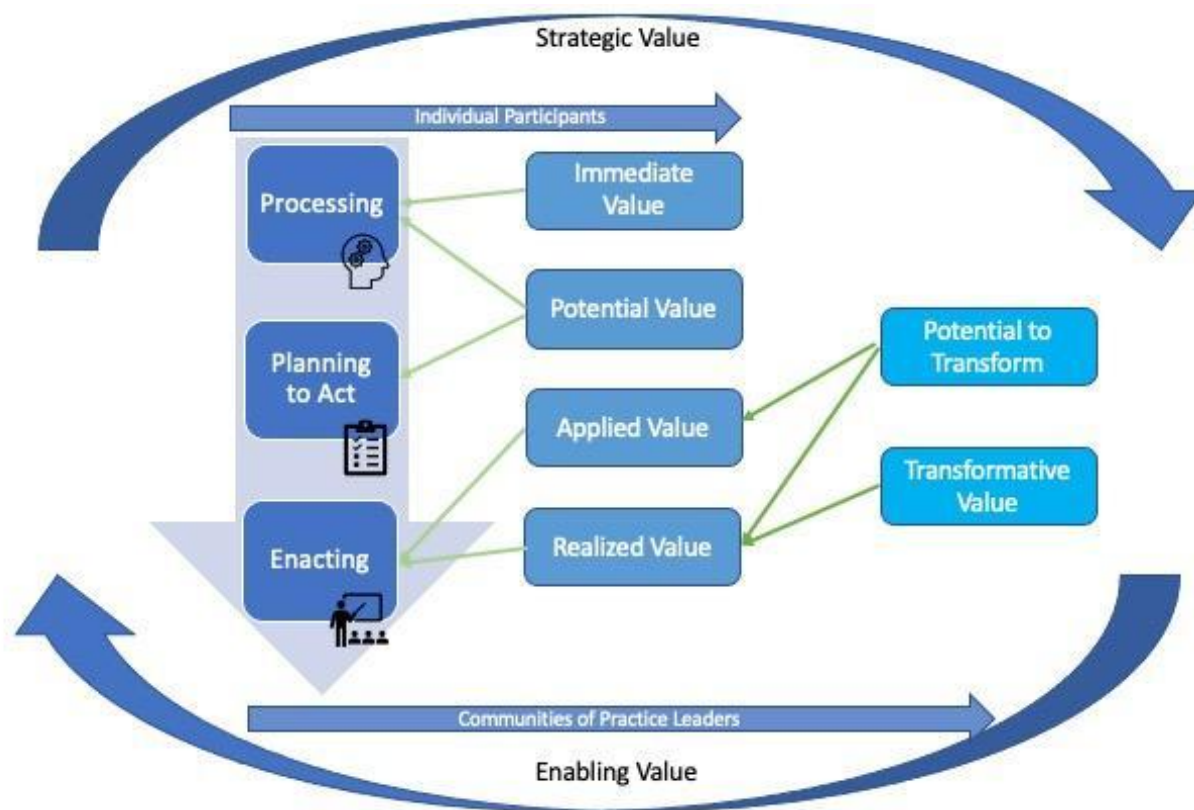


Figure 2. Value creation for community of practice leaders.

We realized that the ways in which value is created through the COMMIT Network for faculty participants is different from that of COMMIT leaders. In the figure above, we attempt to articulate our vision of this hypothesis. The five layers of value creation all lead participants to process and consider new ideas, to make plans and imagine acting on the new information, and eventually to enact these plans in their practice. For individual faculty members, this most often encompasses the first four layers of value: immediate, potential, applied, and realized. They consider new ideas, plan for them, and then implement them in their mathematics courses. They may consider sharing these ideas with others, yet in our findings this typically happened due to the support of their COMMIT and the larger COMMIT Network through established structures like regular meetings, book clubs, and online workshops.

In our consideration of the value COMMIT leaders experienced in their COMMITs and in the Network, however, we overwhelmingly saw more evidence of their plans to share at the regional and network level in addition to the ways they identified their COMMITs as currently acting to share and transform with other COMMITs in the Network.

Implications and Conclusion

To date, we have found the value creation framework first established by Wenger et al. (2011) to be an invaluable tool for studying the potential impacts of STEM CoPs on instructional transformation, particularly at the individual participant level. CoPs are meant to meet the needs of individual participants in a specific area or domain, however, evolution and sustainability are often a challenge once their needs are met (Wenger et al., 2002). Knowing the contextual factors impacting CoPs, we recognize that the ways in which value is defined shifts when moving from studying individual participants to regional COMMITs and broader network levels. Our goal moving forward is to continue refining the model based on new and additional data analysis, to more clearly define how leaders interact with their COMMITs and drive not only transformation of practice but also sustainability of the community as a resource. We believe this work can inform others who are studying COMMITs and sustainability, particularly in subject-specific areas, such as mathematics and more broadly STEM education.

Additional studies in different contexts and subject areas can contribute to our developing understanding of CoP sustainability within the framework of value-add. For example, research is currently underway with other STEM CoPs to further examine if and how this work may be similar or different based on variables such as geographic location, participant demographics, etc. This additional research within this project and other STEM projects is needed to help generalize our findings and proposed model. Our team plans to continue our investigation in this area, with future work focused on considering how strategic and enabling value (see Figure 1) may also need to be reimagined when shifting from the value a regional CoP can provide individuals to the value the CoP can find within a broader network structure.

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