



MISO (Maximizing the Impact of STEM Outreach Through Data-Driven Decision-Making): Building and Evaluating a Community of Practice

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Abstract

This paper describes the second phase of MISO (Maximizing the Impact of STEM Outreach through Data-driven Decision-Making), a campus-wide project, funded by the National Science Foundation, at North Carolina State University. Central to the second phase of the project is the creation of a *Community of Practice* (CoP) among STEM outreach providers on campus. During the first phase of the project, outreach providers were brought together to develop a better understanding of their goals and strategies for their programs. Over this past summer (the midpoint of the project), the external evaluator undertook a comprehensive review of how successful the project has been at fostering a community of practice using Wenger's (2011) CoP model. This model describes five cycles of a CoP and was used to frame a set of questions to be posed to the outreach partners in this project as part of semi-structured interviews. All key stakeholders were contacted with seven in-depth interviews conducted. Described is an analysis of these interviews and the lessons learned thus far for creating a campus-wide community of practice of STEM outreach providers and the development of data-driven decision-making tools to help support the continuous improvement goals of these programs. Findings from the evaluation indicate growth over many of the cycles of a CoP with stronger evidence found in the earlier cycles, but considerable promise of future growth. These findings will be highlighted as well as the future strategies for building the community, as informed by this evaluation.

Introduction

MISO (Maximizing the Impact of STEM Outreach through Data-driven Decision-Making) is a campus-wide project, funded by the National Science Foundation, at North Carolina State University (NCSU). The overall mission of the MISO project is to creatively engage the outreach community across campus in data-driven decision-making. This project seeks to both better understand and support the collective impact of K-12 STEM outreach efforts of the university with the ultimate goal of helping ensure the breadth and depth of the future U.S. STEM workforce.

Specifically, the goals of the MISO project are to:

- 1) *Provide an innovative network of support and communications among University-based outreach project directors and educational evaluation experts, creating a learning community to promote sharing of best practices and innovation that will deepen the impact of NCSU's pre-college STEM programs on students' future academic and career choices.*
- 2) *Develop and demonstrate a system of data-driven planning and analysis guided by best practices to facilitate longitudinal assessment of participant outcomes through development of a common STEM Outreach Evaluation Protocol as well as a database integrating records of NCSU K-12 outreach participants with NC Department of Public Instruction and university enrollment records.*

- 3) *Use the longitudinal assessment of outreach participant outcomes within the university-wide outreach learning community to support more seamless transitions across critical educational junctures.*
- 4) *Broaden participation among underrepresented groups in pre-college STEM outreach activities.*

The MISO project is currently completing its third year. The focus in years one and two was foundational work for all of the core project goals and included the development of a set of standardized survey instruments, recruitment of participants, piloting and full-scale implementation of data collection activities and preliminary reporting of student and teacher outcomes based on the survey instruments. Central to the success of the project is the development of a sense of community among the STEM outreach providers on campus. Success of the MISO project would depend on these providers working together to learn how to improve their outreach programs through data-driven decision-making. While support in development of a “learning community” has been ongoing for the duration of the project, year three provides the perfect “mid-point” at which to assess our efforts towards this goal.

Communities of Practice

The literature on the development and support of learning communities demonstrates that one approach to developing a robust, efficacious project such as MISO is to create a *Community of Practice* (CoP).^{1,5} CoPs are not uniform in nature and can vary widely depending on the needs of the community.² In fact, evidence of the creation of a CoP can start small (e.g. community website or virtual space for learning). Lesser asserts that “as organizations grow in size, geographical scope, and complexity, it is increasingly apparent that sponsorship and support of communities of practice—groups whose members regularly engage in sharing and learning, based on common interests—can improve organizational performance.”³ Ultimately, organizations, even at the project level, can benefit from the underlying social mechanisms that distinguish CoPs. Lesser found that there are specific outcomes associated with communities of practice that include: 1) connections among practitioners; 2) relationships that build a sense of trust or mutual obligation; 3) and a common language and context [and, as in the case of MISO, shared goals] that can be shared by CoP members.

Another area that is salient to the MISO project, in its capacity as a developing project, is the idea of MISO being a learning organization.⁴ Learning organizations deal with five systemic tensions, and the ability of MISO to balance these tensions will be critical to its success. The first is the partners’ desire to learn. The second is the investment in the learning initiative versus a need to keep the status quo in an effort to keep costs low. Third is the balance of formal learning (workshops) and informal learning (visits from project staff). Fourth is the flexibility within the context of the project that may be different than organization-wide expectations. Lastly, balancing people and technology.

In an effort to better understand the linkage between the outcomes of the MISO project and its outreach partners, an external evaluation of the MISO CoP was initiated in the spring of 2013. The MISO project team and stakeholders were interested in understanding the unique qualities of the MISO community of practice and the impact that the community of practice had on the

project's ability to achieve its stated goals of creating a learning community. Wenger's CoP model, and the five cycles outlined in the model, provides a particularly useful framework for the exploration of the development of the CoP.^{1,5} Wenger's model, built on prior research by Wenger, his colleagues, and other researchers was designed specifically to better understand what value a CoP creates towards the larger outcome of projects such as MISO; where it is believed that the sharing of information and expertise within an organizational network is central to project goals. Wenger's model frames five types, or cycles of value creation—from more immediate to aspirational—that a CoP might contribute to project outcomes (Figure 1). The five cycles and evidence of achievement of each cycle were used to frame a set of questions to be posed to the outreach partners in this project as part of semi-structured interviews (Table 1).

This paper will both recap the recent work of the project and report on the findings from interviews based on the Wenger CoP framework (Table 2). In particular, it will address perceived value of the MISO project by partners, dissemination of knowledge and ideas, changes in project performance, and expansion of project impact beyond the immediate key stakeholders. It will be organized by a brief recap of year two activities, overview of evaluation questions and methodology, key findings, and strategies for the future.

Recap of Year Two Activities

Much of year two was devoted to the development of the STEM outreach surveys and the building of an online system for data collection and analysis. MISO has successfully created a system to collect and house longitudinal student and teacher data for the purposes of identifying common STEM outcomes among these two groups. MISO project partners continue to express their perceived value of the project by continuing to use the standardized evaluation tool and by sharing information with other NCSU STEM outreach programs. Prior to the MISO project, several of the partners did not have a formal method of assessing their programs, so this process of systematic and rigorous survey data collection and analysis was a new process for them.

Evaluation Methodology

A review of the NSF Innovation through Institutional Integration (I³, the funding program) website resources for I³ evaluation revealed a broad range of topics that were of interest to NSF in terms of evaluation focus. Among them were evaluating sustainability, evaluating innovation, and evaluating networks and partnership. Having completed a significant amount of work toward initial project goals by the close of year three, MISO was in a better position to explore project outcomes as they relate to sustainability, innovation, and partnerships.

How to explore the issues of sustainability, innovation, and partnerships was of particular interest to the MISO team. As a result, the team determined that the most comprehensive approach to evaluating these aspects of the project would be to use a “community of practice” model. In recent years this phrase has been used with increasing frequency as an indicator of project success. In an effort to use a systematic and “tested” approach to measuring this concept, the MISO external evaluator drew on the work of Wenger and colleagues as a basis for the evaluation design.^{1,5} The Wenger model provides a practical approach to measuring the value

impact of a learning community (CoP) as well as specific indicators along a continuum that includes five specific developmental levels for a CoP.

Data collection strategies

A. Key Stakeholder Interviews

Key stakeholder interviews were used as the primary data collection method and were conducted during the spring of 2013 by the external evaluator. The interviews were conducted by phone and by email. Both methods provided adequate opportunity for participants to provide honest and confidential feedback on the MISO project with respect to their own participation and interests. Interviews were semi-structured around the Wenger indicators (Table 1). Interviewees were asked to reflect on the five different stages of development in a “community of practice.” All key stakeholders were contacted, with seven in-depth interviews conducted.

B. Additional Data Collection Methods

Additional data collection methods included document reviews and direct observations of meetings and workshops (Table 2). Documents reviewed for this report included meeting agendas, meeting minutes, meeting presentations (e.g., PowerPoint slides), evaluation summaries, coordinator notes, and work products (e.g., surveys, website, etc.). In addition, the evaluator participated in and was a presenter at the December 2012 workshop and participated in PI meetings and advisory meetings. Observations were serendipitous and did not include a formal protocol. Note that the findings below are organized by Wenger’s CoP Levels. Where appropriate, the data source is indicated in parenthesis. A full implementation summary is included in the “Discussion” section of this paper.

Findings

A. Community of Practice Level One: Immediate Value

The Wenger model notes that during the early phases of the growth of a learning community, members may realize what he calls “immediate value.” Immediate value is defined as the early activities and interactions of the group. This also includes significant events that have taken place within the scope of the project. In this case the MISO Project Coordinator provided detailed weekly notes of the activities conducted in conjunction with other team members.

Highlights of the activities for Year 3 include:

- Participation in conferences for the purposes of knowledge dissemination
- Team meetings to for the purposes of project improvement
- Testing and refining data collection procedures (e.g. adding a mobile iPad unit for programs that don’t have easy access to computer labs)
- Ongoing technical assistance for existing outreach partners
- Meetings with new partners to provide technical assistance and training on the use of the tools and logistics of data collection
- “Recruitment” meetings, phone calls, and correspondence with potential partners
- Networking with other organizations outside of the university
- Renewal of IRB permissions

B. Level of Participation, Activity, and Engagement

A critical activity for MISO identified for year three was for MISO to provide a pre-college outreach workshop on best practices, broadening participation, and critical educational transitions. Workshops and advisory committee meetings were held in years one and two. The workshop format continued into year three and included a November 2012 workshop intended to provide attendees with a deeper understanding of the IRB process, including helpful hints and an introduction to help them navigate the IRB review process before they create an IRB submission; and also learned how to understand the process of engaging an external evaluator for their project or program, including determining when they need an external evaluator, choosing one that is the right fit for them, and what is the relationship between a project coordinator and an external evaluator. These workshops serve a purpose in that they provide the immediate value of new knowledge. They also serve to enhance the partnerships that were created in the early years of the project and to bring new “recruits” to the table. A total of 25 people (all NCSU K12 STEM outreach coordinators, or interested staff or faculty) attended the November workshop. Interview data from outreach partners suggest that all partners who have attended at least one MISO workshop found the workshops to be useful. Attendees were not given stipends or credit; instead receiving new and practical knowledge incentivized them.

In addition to providing workshops as a resource to outreach partners, MISO continued to update and refine the website (<http://ncsu.edu/miso>). Online resources and social networking are increasingly popular forums for exchanging information. The MISO website currently hosts links for outreach providers, for parents who are looking for outreach opportunities, and for teachers who are looking for training opportunities. There is also a provider directory and additional resources for anyone interested in learning more about the MISO project or evaluation concepts in general. Between July of 2012 and May of 2013, a total of 2,292 people had visited the website.

PI meetings were held regularly throughout the year to discuss the project successes and challenges. During PI meetings, team members review progress to date and develop action items for the upcoming months to ensure that the project continues to be implemented according to the proposal. A PI meeting was held in February 2013 to discuss opportunities for dissemination of the project through journal articles, developing an external evaluation interview protocol to measure “community of practice”, and determine a way to collect information on student participation in pre-college outreach activities through the universal college application process. As a follow-up to the PI meetings, an advisory team meeting was held in May 2013 to discuss project updates and to share the findings from the community of practice interviews.

The partnerships created as a result of MISO have the capacity to impact a large number of students, both within the university STEM outreach system and beyond. Currently, 24 student programs and 7 teacher programs partner with the MISO project. They are active in workshops, meetings, and having their program participants take the surveys. For example, the student programs included summer camps in engineering, vet studies, nuclear engineering, natural sciences and horticulture. Teacher programs included professional development, leading summer camps, and workshops. In total, the MISO project had reached approximately 5000 students and teachers at the time of the evaluation.

C. Quality of Interactions, Perceived Value, and Networking and Collaboration

Several key stakeholder interview questions were focused on higher level indicators of community of practice. It should be noted that some of the questions blend with the second level of community of practice, or “Potential Value.” The evaluator asked the participants to address new partnerships and what types of interactions they are having or have had with new partners. A common denominator among all interview participants was that, prior to MISO, they were not aware of all of the different STEM outreach activities on NCSU campus. At earlier workshops (years one and two) there were opportunities for initial meetings and interactions, and it appears, at least from the perspectives of the key partners who participated in the interviews, that these relationships offer new opportunities for collaboration. For example, if one summer camp for students has a waiting list, camp organizers can refer parents to other STEM outreach opportunities on campus (Advisory Team notes, May 2013). Partners who consider themselves “active” or at least “interested” shared that “they are trying to take advantage of every opportunity” and that they “enjoy the opportunity to learn about what others are doing” (interview notes).

Additional evidence of the immediate value of the project is the actual use of the MISO-based resources available to partners. Specifically, the initial use of the teacher and student evaluation survey instruments (T-STEM survey and S-STEM survey) has proven to be a big help among those partners who feel their existing evaluation systems are lacking in appropriate, high quality data:

We were doing evaluation before, but the worst kind of evaluation. By that I mean, we were collecting data and not looking at the results. We weren't always asking the right questions. Now that we have a standardized instrument like the MISO surveys, I am able to work with our assessment director here. We are learning as we go. (interview notes)

Community of Practice Level Two: Potential Value

A. New Skills, Change in Perspective, Quality of Output

Perhaps the most compelling evidence of a burgeoning community of practice is that of the level of self-evaluation skill advancement among some of the participants. A few of the key outreach partners were already conducting evaluation activities and were familiar with issues such as the importance of timing, the format of the instrument, the audience, and ease of use. For others, however, this was not the case. Even those outreach programs that were conducting the typical “satisfaction survey” evaluation learned that logistical challenges must be addressed in order to achieve validity of the responses. One interviewee described the process of learning:

We continue to work on data issues. For example, we had pre and post inconsistencies and we learned that you can't let [the teachers] leave and expect them to complete the surveys on their own at a later time. We also have to deal with equipment and technology issues when completing online surveys especially if you have 72 kids and the survey takes twenty minutes.

Another reported learning curve from one interviewee concerned the issue of balance when asking clients to participate in evaluation activities. She reported that participation in the MISO surveying has caused her to ask “how much is too much?” Her project had other instruments they

were required to use, and while she was informed by MISO staff that she could add questions to the MISO surveys, she has not taken the time to do it. However, other interviewees felt that they might be able to forego their old evaluation tools in favor of the MISO survey, because, as one interviewee noted, the use of a standardized tool might make for better quality data.

Community of Practice Level Three: Applied Value

A. Implementation of Solutions, Innovations in Practice, Use of Tools to Inform Practice

In terms of implementation, the external evaluator concluded that the MISO project had “hit its stride” in year three. Interviews indicated that most outreach partners were able to articulate the value of the survey instruments, know how to interpret the data and understand how the data can potentially inform what they do. When asked how his outreach project is using the data, one interviewee responded that they were “using the data in an iterative way to make changes to the project. For example, we have become more data oriented in our approach to professional development.” Another interviewee shared her experience with MISO and how, ultimately, they felt it will become a formative tool for their work:

If I can use a building or engineering analogy....we are able to do these evaluations with the support and scaffolding that MISO provides—knowing that eventually this is going to become a really cool building. We are only scratching the surface of what we can hope to achieve. We are here to impact kids. The only way to do it objectively is through data.

The evaluator concluded that while MISO may not be creating full-scale changes in programs at this point, outreach partners were giving more thought to how to use the data to “tweak” practice. There is, however, still work to do. For example, data are only useful if they are timely and accurate reflections of the outreach project. To date, the MISO Project Coordinator has spent considerable time assisting outreach projects in overcoming logistical issues with data gathering. Once outreach projects fully adopt the process and are able to carry out data collection, reporting, and data interpretation on their own, the evaluator concluded, we will be able to deem MISO “institutionalized.”

B. Re-Use of Products, Use of Social Connections, and Transfer of Learning Practices

There was a lot of evidence at the higher level of the MISO project (the data analytics component, principal investigator interactions), that MISO is creating a “buzz” in the often difficult to access research and publication world. An update from the Data Analytics Coordinator indicates that over 150 researchers, nationally and internationally, had accessed the S-STEM survey and the T-STEM survey for their own research. In addition, the PIs are continuously looking for opportunities to present their work. For example, in October 2013, MISO team members presented at a state-wide STEM pipeline policy conference, as well as the national AEA conference. From this state-wide conference, two new partners were recruited to the MISO Project.

A practice that was initiated early in the MISO process was to assist projects in developing “logic models” or “logic mapping”, so that they could map the link between their activities or “interventions” and their intended outcomes for students or teachers. The Project Coordinator indicated that outreach programs continued to refine their outcomes using the mapping process.

The evaluator concluded that this transfer of learning practices may prove useful to all outreach projects as common STEM outcomes begin to be associated with specific interventions and target populations. For example, when sufficient, positive S-STEM or T-STEM outcome survey data can be linked to a certain intervention and target population (e.g. a school year program targeting minority high school juniors), then any outreach projects whose goal it is to target that particular population will know specifically which interventions work and how (how many contact hours, hands-on activities versus lecture format, etc.). This is powerful information, particularly for start-up projects or funding applications.

Community of Practice Level Four/Five: Realized Value and Applied Value

The evaluator concluded that at the close of year three, the development of a CoP around the MISO project had solidly achieved levels one and two on the Wenger scale and was well into level three. Sufficient evidence was to be found to support this in program artifacts, evaluator observations and interview data. Outreach partners were beginning to see some initial movement into the “realized value” of the project, or, on the Wenger scale, level four. Perhaps the most promising evidence of the continued growth of the community of practice is that outreach partners are beginning to use the S-STEM and T-STEM survey instruments with their own partners outside of the university. For example, the engineering education outreach group was working with the local Boys and Girls Club to implement the pre-test component of the S-STEM Upper Elementary survey. In addition, at least three outreach partners had written the survey use and analysis process into evaluation sections of grant proposals. The idea was that a validated instrument can provide useful data has been appealing to outreach partners and may prove appealing to funders as well. These types of actions opens the door for a future “return on investment” value added measure of MISO. As the project moves into the last two years, the project team and external evaluators will continue to monitor the growth of a community of practice. As we continue our study of the MISO CoP we will attempt to quantify our findings by converting the indicators in the CoP to a "post-then-pre" survey format which will be administered at the close of the grant cycle. Survey items will be analyzed to pinpoint positive movement along the CoP Scale.

Future strategies

The challenge at this time is to help project partners *use* the data that the surveys generate and put it into action to help improve and focus their outreach activities. Some are using the information more than others, but ultimately the goal should be to have all partners using their data. The hope is that we can connect survey outcome data to interventions that can be infused throughout the CoP. What interventions work for what populations? MISO has the opportunity to begin to answer this question if interventions can be linked to survey data. To support their program partners, MISO made the decision to hire a new MISO staff member to work very closely with the project coordinator "in the field." Together with the Project Coordinator, they are working with the partners to figure out how they plan to use the data, and what changes they might implement based on the data. Following these one-to-one data meetings, the MISO team will hold a workshop, tailored to address the needs that have arisen based on the meeting outcomes.

Conclusion

Findings from the MISO project evaluation using the Wenger model indicate growth over many of the cycles of a CoP, with stronger evidence found in the earlier cycles, but considerable promise of future growth. The continued development of a CoP and its value to the MISO project goals is evident in the project outcomes and the interviews summarized in this paper. Figure 1 shows a graphic depiction of a summary of these achievements that evidence each of the cycles of community of practice. Movement of the arrows to the right indicates a higher achievement of that level on the scale.

As is typical with any developing partnerships, MISO began in year one as a small, loosely developed network of partners. While networks and learning communities are complementary in practice, innovations are more sustainable when partnerships move more toward a “community” and a shared vision or goal.¹ Ultimately, the measure of the full development of a learning community will be to ask and affirmatively answer, “if MISO were to go away, would the learning community carry on the work of networking, data-gathering, and information sharing?” MISO has demonstrated in year three that partners are collectively moving “towards a whole that exceeds the sum of its parts” (NSF I³ website). The project has been on target with each of its objectives in years one through three and the movement towards systematizing a valid method of large-scale, university-wide, STEM outreach data gathering will continue as planned into years four and five. As was the case for years one through three, success in years four and five will depend on continued growth and perceived value of the CoP.

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Appendix

Figure 1. Cycles of achievement (Based on Wenger, et al.^{1,5})

MISO “community of practice” (adapted from Wenger model, 2011)

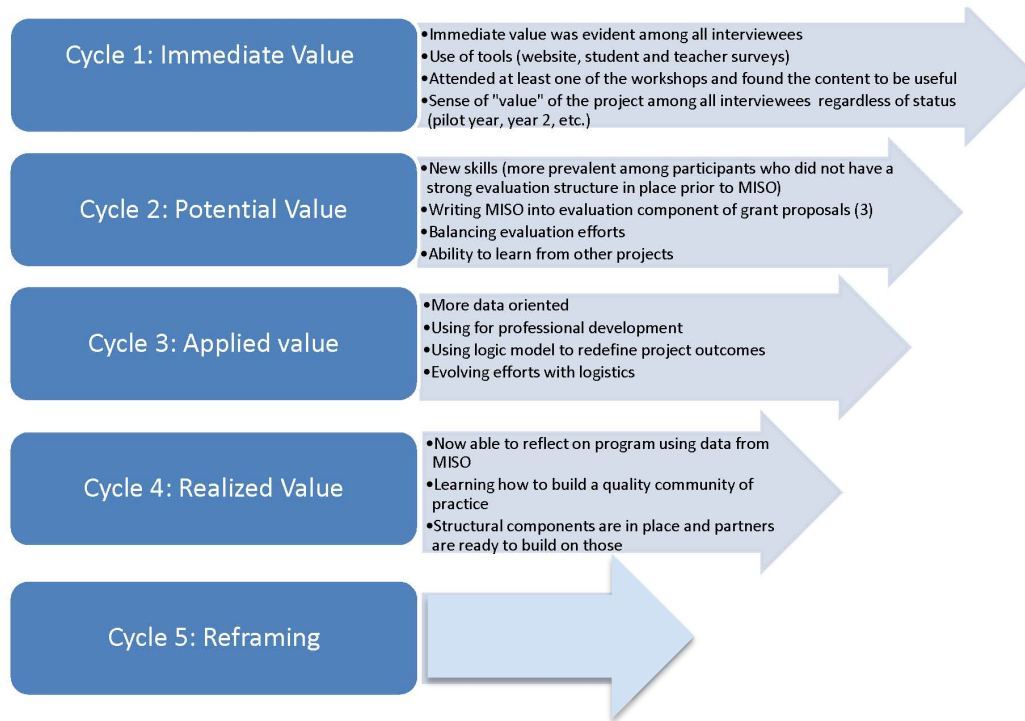


Table 1. Interview Questions (based on Wenger, et al.¹)

Community of Practice “Level of Value”	Evaluation Questions
Cycle 1: Immediate Value (Activities and Interactions)	<ol style="list-style-type: none"> 1. What significant project events have taken place? Did you participate in them? 2. How relevant was the activity to your project/needs? 3. With whom did you interact? 4. What connections did you make that were useful to you?
Cycle 2: Potential Value (What has all this activity produced?)	<ol style="list-style-type: none"> 1. Did you acquire new skills or knowledge? 2. Did your understanding of the purpose

	<p>of the project change?</p> <ol style="list-style-type: none"> 3. Do you feel MISO is assisting you in your own evaluation efforts? 4. Do you feel more confident in conducting evaluation activities as a result of MISO? 5. Do you have access to more contacts within the university or with other outreach projects? 6. Do you see opportunities stemming from MISO that you were not aware of before?
<p>Cycle 3: Applied Value (What difference has it made to practice?)</p>	<ol style="list-style-type: none"> 1. How have you used the MISO products (assessments)? 2. Are you applying anything you have learned from MISO in your current work? 3. Did you use MISO to leverage other resources? 4. Have you enlisted others who have participated in MISO (or MISO staff) to assist you in expanding your assessment efforts?
<p>Cycle 4: Realized Value</p>	<ol style="list-style-type: none"> 1. Would you consider yourself an active participant in the MISO project/community? 2. Do you feel MISO has affected metrics (or assessments) that you use to evaluate performance? 3. What have you been able to achieve as a result of your participation in MISO?
<p>Cycle 5: Reframing Value: (Has participation changed understanding?)</p>	<ol style="list-style-type: none"> 1. Has participation in MISO changed the way you think about any aspect of our project (project planning, implementation, evaluation)? 2. Has this new way of thinking resulted in any organizational change that you can identify?

Table 2. Data Sources for Analysis (based on Wenger, et al.¹)

Community of Practice “Level of Value”	Indicators	Sources of Data
Cycle 1: Immediate Value	Level of Participation	Attendance at meetings
		Number of ‘active’ participants
		People who subscribe to site
		Logs and web stats
	Level of Activity	Frequency of meetings
		Number of queries
		Quantity and timeliness of responses
	Level of Engagement	Intensity of discussions
		Challenges Assumptions
	Quality of Interactions	Bringing experience of practice into learning
		Feedback on quality of responses to queries
	Value of participation	People coming back to community or re-engaging with the networks
	Networking and Collaboration	New connections made
		Co-authorship
Cycle 2: Potential Value (Indicators of knowledge capital)	Skills acquired	Self-report/interviews
	Information received	
	Change in perspective	
	Confidence	
	Level of Trust	
	Quality of output	
	New views of learning	
Cycle 3: Applied value (changes in practice)	Implementation of solutions	Self-report/Interviews
	Innovations in practice	
	Use of tools and documents to inform practice	
	Re-use of products	
	Use of social	

	connections	
	Transfer of learning practices	Using communities' processes and tools for learning in other contexts
Cycle 4: Realized Value (performance improvement)	Personal performance	Improvements in performance of target population (students, teachers, etc) who are served by project using tools to inform practice
	Organizational performance	Project assessments
	Organizational reputation	Using data to attract new clients, funding, etc.
	Knowledge	Direct delivery of knowledge products to clients
Cycle 5: Reframing value (redefining success)	Community aspirations	New learning agenda
		New discourse about value
		Refined assessment processes (how much flexibility is needed?)
		Involvement of new stakeholders
		New strategic directions that reflect new understanding
		New social, institutional, or political systems (emerging or created)