



Marcellus Matters EASE:

Project Overview

Summative Evaluation Report

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Executive Summary

Marcellus Matters: Engaging Adults in Science and Energy (EASE) was a program of Penn State University's Marcellus Center for Outreach and Research (MCOR), in collaboration with other experts across the university. The first year of program activities took place in 2012, and the project continued through September 2016. EASE was a multidisciplinary initiative that provided adults in rural Pennsylvania with opportunities to increase their knowledge of science and energy systems and engage in scientific inquiry and investigation through the lens of natural gas development. In its initial stages, the project stated five goals:

- 1) Participants will increase their knowledge of science and engineering related to energy consumption, production, and policy;
- 2) Participants will build a shared knowledge base on science and energy to empower rural communities in making decisions and managing change;
- 3) Participants will apply the skills of scientific inquiry and investigation by engaging in "community" or "citizen" science;
- 4) Participants will learn effective strategies for deliberation of complex environmental issues;
- 5) A model of community engagement and capacity building in science and energy will be created.

The first four goals were constructed into the four activities of the program, and the fifth was intended to be an overall summation of the program approach. The initial design of the project was that four components of the project would interact to lead to a change of dialogue in the community around Marcellus Shale extraction and transportation, primarily in the Northeast and Central Pennsylvania region.

This evaluation was designed to answer questions emerging from the five goals of the project. To summarize the successes of the project, brief responses to each question are included below.

1. Did participants increase their knowledge of science and engineering related to energy consumption, production, and policy?

Yes. Across activities, participants gained scientific knowledge and engaged in (usually) civil discourse. In particular, the Community Science Volunteers course and MarcellusByDesign events helped introduce participants to new ideas and approaches to the science content and issues related to shale gas development. Meanwhile, both MarcellusByDesign and Community Conversations events served to highlight the complexity of shale gas development through the lens of participants' lived experiences, as well as the concerns germane to individual communities. To build on these other areas, the Marcellus Citizen Science Network improved participants' knowledge of a specific facet of the legacy of energy development, immersed participants in scientific processes, and provided opportunities to practice skills in real-world settings.

2. Did participants build a shared knowledge base on science and energy to empower rural communities in making decisions and managing change?

To some degree. There was shared knowledge within any component. Because of the shifts in the program design, there was no means by which to determine the degree to which communities were empowered. Elements of the program did show anecdotal evidence of making significant change. In

connection with MarcellusByDesign, several planning departments have used tools and information from the workshops in developing ideas for their communities. Some participants in the Community Science Volunteers course have continued to discuss energy issues and share their knowledge with others; this has been particularly true for Sullivan County, where past CSV participants organized a regular “breakfast club” and held community events. Meanwhile, Penn State’s Theatre department is using the structure developed for the Community Conversations to facilitate science communication across the university. Finally, the Marcellus Citizen Science Network has full support and engagement from the state Department of Environmental Protection (DEP), which is positioned to lead ongoing efforts to document community data in online repositories. These indicators of impact reveal the power of components, and suggest what might have been had the model held true.

3. Did participants apply skills of scientific inquiry and investigation by engaging in community or citizen science?

To some degree. As the components were not cumulative, the range of activity was limited within each of the individual programs. For example, the sustained contact inherent to the Community Science Volunteers course allowed participants for much deeper immersion across the skills, whereas those who participated in the Marcellus Citizen Science Network learned and applied skills in authentic ways. Although these programs had some audience overlap, the changes to the overall project trajectory meant that these connections were not consistent enough to be tracked in a meaningful way.

4. Did participants learn effective strategies for deliberation of complex environmental issues?

Yes. In each of the components, effective strategies were modeled and participants engaged in deliberation to varying degrees. Because of the shift in the program model, the impacts were not cumulative, so there was no tracking of change across activities, yet each component met its desired outcomes. Even in the settings where imported activists were present, the dialogue remained civil as different ideas were expressed. Only in the media following events was inflammatory language used, and never by local citizens who participated in the programs.

5. Was a model of community engagement and capacity building in science and energy created?

To some degree. The changes in the program shifted the focus from a unified program leading to civil discourse and greater engagement, but allowed the program components to each approach the challenge independently. Each component worked, and over the course of the project each component became highly effective on its own, but the overall model did not reach the level of community engagement initially desired. Those involved in the Marcellus Community Volunteers course had a high degree of positive capacity change in science and energy, as did those involved in the Marcellus Citizen Science Network. Participants in the Community Conversations had a strong shift in understanding the complexity of emotions involved in the scientific and environmental issues, and those who attended MarcellusByDesign workshops gained great insights into strategies and considerations for decision-making around the shale gas issue. Across these elements, several key personnel provided some consistency for participants. This allowed for important relationship-building, which in turn enabled individual programs to pivot toward beginning to understand and address local audiences’ needs and interests.

Table of Contents

Introduction.....	1
The Project Design.....	1
Pilot and Formative Evaluation.....	4
Community Science Volunteers.....	4
Community Conversations.....	8
Team Communication Study.....	9
Cumulative Summative Evaluation.....	12
Community Science Volunteers.....	12
Methods.....	12
Findings.....	12
Conclusions.....	15
Community Conversations.....	15
Methods.....	15
Findings from Audience Data.....	16
Team Reflections.....	17
Conclusions.....	18
MarcellusByDesign.....	19
Methods.....	19
Findings.....	19
Program Refinement and Sustainability.....	21
Audience Expectations and Needs.....	22
Audience Takeaways and Experiences.....	22
Conclusions.....	23
Marcellus Citizen Science Network.....	24
Methods.....	24
Findings.....	25
Conclusions.....	27
Conclusions.....	29
Appendix A: Legacy Products	
Appendix B: Team Reflections on Programs	

Introduction

Marcellus Matters: Engaging Adults in Science and Energy (EASE) was a program of Penn State University's Marcellus Center for Outreach and Research (MCOR), in collaboration with other experts across the university. The first year of program activities took place in 2012, and the project continued through September 2016. EASE was a multidisciplinary initiative that provided adults in rural Pennsylvania with opportunities to increase their knowledge of science and energy systems and engage in scientific inquiry and investigation through the lens of natural gas development.

The present report looks across the various programmatic activities to describe the general trajectory of the project and the overarching takeaways from the project as a whole.

In its initial stages, the project stated five goals:

- 1) Participants will increase their knowledge of science and engineering related to energy consumption, production, and policy;
- 2) Participants will build a shared knowledge base on science and energy to empower rural communities in making decisions and managing change;
- 3) Participants will apply the skills of scientific inquiry and investigation by engaging in "community" or "citizen" science;
- 4) Participants will learn effective strategies for deliberation of complex environmental issues;
- 5) A model of community engagement and capacity building in science and energy will be created.

The first four goals were constructed into the four activities of the program, and the fifth was intended to be an overall summation of the program approach. The initial design of the project was that four components of the project would interact to lead to a change of dialogue in the community around Marcellus Shale extraction and transportation, primarily in the Northeast and Central Pennsylvania region.

The Project Design

Over the course of the project lifespan, necessary changes were made in the program model. The elements of the project that were dependent on each other had to become independent experiences. All program components occurred in each community, but the sequence, interdependence, and cumulative aspects of the original design were altered. The following graphic illustrates the four components of the program and how they intersect around the goal of civil engagement.

The original project design had three inter-related activities: 1) Community Master Scientists who would participate in an intensive training program, then serve as ambassadors for good science and civil discourse around shale gas discussions in the community and promote the other components; 2) Community Conversations which were to be theatre pieces leading into discussions among audiences and scientists; and 3) Planning workshops which would engage citizens in exercises to help them understand the challenges and opportunities for planning after the shale gas extraction is no longer a 'boom.' These three components would all be supported by, and connected through a web site that would be designed to support the Community Master Scientists.

There were challenges to implementation when the University determined that they would not allow the Master Scientist title to be affiliated with PSU due to the sensitivity of the topic. The project had to radically shift to what was reframed as the Community Science Volunteers (CSV) program, which included the same course, but did not have the requirements for service in the community. The model below shows the hypothesized, original structure of the project and how the components were to interact (with dotted arrows indicating shared audiences and resources).



Figure 1. Original Project Model

The initial change forced other changes and the sequencing and interaction of the activities shifted. Community Science Volunteers was particularly consistent in its linkages to other project elements, in that CSV participants were often eager to attend additional EASE programming and therefore represented a prominent segment of the audiences for the other three programs. Given the project timeline, this was particularly true early in the project for Community Conversations events; later in the project, community planning workshops and a new citizen science element were implemented, and both included past CSV participants as part of their outreach.

Community Science Volunteers, the Community Conversations, and the Environmental Planning Workshops (eventually known as MarcellusByDesign) all did continue to focus on creating civil dialogue in participating communities. Before the summative work began, the project model was reconceptualized to better illustrate how the project did unfold. Because of the independence of

the elements, the summative evaluation was designed to look at the pieces by themselves, and to describe the efforts overall.

The model below shows the revised conceptual model for the project with the four components of the program in the evaluation and how they intersect around the goal of civil engagement.



Figure 2. Reconceptualized Project Model

Pilot and Formative Evaluation

Community Science Volunteers

Approximately 148 individuals fully completed the Community Science Volunteer program, across seven iterations between 2012 and 2016. Throughout each course, weekly sessions, mostly classroom-based, addressed a series of topics relevant to Marcellus shale, gas drilling, and related science concepts and/or community issues.

Because each class involved an eight- to ten-week commitment and was based in an individual community for each iteration, the CSV program was cohort-based and structured around sustained, consistent participation.¹ As this was the most contact intensive activity of EASE, it was in this effort where the most significant impact on individuals was expected, both in terms of building their individual science literacy and in terms of their continued action in their communities.

Summative evaluation of the CSV program included a set of post- and delayed post measures beginning in the fall of 2012; these instruments were developed alongside formative-stage instruments and revised based on findings from the formative evaluation. As this component was the heart of the project, more detail on the pilot is presented than for the other studies; this is done as significant changes were made from the pilot to the second cohort after which the course was continually tweaked, but structurally remained consistent. Nonetheless, this section presents only the key findings and takeaways from the formative phase to avoid redundancy in describing summative evaluation. A full report from the formative evaluation phase can be found online: <http://www.informalscience.org/marcellus-matters-ease-marcellus-community-science-volunteer-formative-evaluation>

Two key questions were at the center of this formative evaluation:

- 1) To what extent is the program effective at cultivating...
 - Participants' knowledge of gas drilling-related science content?
 - Participants' self-perceived knowledge / expertise on gas drilling-related issues?
 - Participants' informal use and/or sharing of new gas drilling-related information in their communities?

- 2) Which of the program sessions' structures (i.e., written materials, lecture, hands-on activity, discussion, large vs. small group work, etc.) do participants find most effective at conveying the various topics of the program?

Methods

The formative evaluation was a census study of all participants in the pilot cohort. Four different questionnaires were distributed to participants² at different times in relation to each of the activity's eight sessions:

¹ Notably, the course was extended from eight weeks to ten weeks after the third cohort in response to formative feedback from participants.

² Due to weekly variation in instructors and other factors, all four questionnaires were not necessarily distributed at each session. The instruments used in each session are noted in the Findings section below.

- pre-session items addressed the structure of written overview materials that were distributed for each session topic;
- post-session items about a session’s effectiveness were completed immediately following each session; and
- a “reflective worksheet,” distributed for completion between one session and the next, asked participants to recall main ideas of the previous session after a short delay;³ and
- a post-program questionnaire rated the success of the program at developing specific content knowledge and skill sets.

Each of the instruments was generated in paper-and-pencil form, and then distributed and collected by EASE program staff. Completed questionnaires were scanned and forwarded to the evaluation team for analysis. Open-ended items from all three instruments were categorized to facilitate some quantitative analysis (e.g., were participants’ pre-session and post-session questions similar to or different from one another). Responses were then coded using emergent categories; where applicable, these coded items were analyzed alongside parallel quantitative items using SPSS. Individual responses to items were mainly analyzed in aggregate across each session.

A post-program questionnaire was also used to solicit participants’ reactions to the program as a whole. This instrument was distributed by mail to a census of the pilot cohort of 25; 22 completed responses were received for a response rate of 88%. A series of rating scales were co-developed with the program team to reflect the eight sessions’ effectiveness at conveying specific knowledge and skill outcomes. Open-ended items about interesting and important program topics were included to explore which topics, if any, were particularly engaging. These items were coded by identifying in a series of dichotomous variables the program session(s), from 1 to 8, where named topics occurred. Two other open-ended items which asked for participant suggestions to change or improve the program were added to provide respondents with opportunities for more concrete critique; these were analyzed and described based on trends which emerged from the data. All quantitative data was analyzed using SPSS.

Findings

This formative study only partially addressed the evaluation questions that pertain to the activity’s intended outcomes; instead it focused mostly on describing the structural effectiveness of the Community Science Volunteer Program: which session topics, activities, and structures the participants found most relevant and/or useful for their learning. In the session-specific portions of this evaluation, the following items (and the instruments on which they appeared) were used to address these different kinds of effectiveness:

- Whether each session was seen as being too simple or too complex (*pre- and post-session*)
- What content-related questions may have been unanswered in each session (*pre- and post-session*)
- What other information, if any, participants wished to see in each session (*pre- and post-session*)

³ For some sessions, the “reflective worksheet” also asked about participants’ use of the previous session’s content, while in others “use” was the topic of an in-session group discussion.

- The extent to which particular activities (e.g. lectures or group discussion) were viewed as helpful (*post-session*)
- Whether participants found any elements of each session as particularly effective, ineffective, or as things they would change about the program (*post-session*)
- What participants viewed as the “big ideas” of each session, and of the program overall (*reflection*)
- Which topics or activities, if any, were particularly memorable for or familiar to participants (*reflection*)
- Whether particular descriptions (e.g. “relevant,” “boring,” etc.) evoked particular reactions about or memories of the program for participants (*reflection*)
- Whether and how participants used (or could imagine using) content from the program in their everyday lives (*reflection*).

In order to facilitate use for program development, findings related to each of these items were originally divided into responses about each of the eight program sessions. The findings presented are at the program-level view of the Community Science Volunteer Program’s successes and areas for improvement.

Trends across sessions

Across all sessions where data were collected, a strong majority of participants reported that both the program sessions (143 of 160 responses, or 92%) and pre-session overview (52 of 61, 85%) materials were “about right” in terms of complexity. Comments describing both “too simple” and “too complex” responses tended to focus on the amount of detail in the session or materials, often noting missing nuance or an abundance of technical language.

Several relatively consistent patterns emerged across the three sets of responses related what seemed to be missing from pre-session materials. In each case, at least ten participants made comments for this item, indicating substantial demand for “more” in general. In the two earlier sessions, but not the later ones, respondents named “missing” information that would appear later in the program. Comments that were related to the topics of the respective sessions, in addition to expressing an interest in greater depth or breadth of information, often called for greater relevance and concreteness of the sessions. A handful of respondents also reported that there should be less information in the sessions. In general, these comments reflected a view that there was not enough time to cover the content presented in each session.

What participants saw as most interesting or important

Participants were asked an open-ended question regarding what they felt were most important and most interesting topics. Overall, it would appear that topics for which participants saw more obvious (or pre-existing) connections to Marcellus Shale – in particular engineering, geology, and hydrology – were mentioned more often as being both most important and most interesting. Participants showed clear favorites they described as “interesting,” with the sessions named most often appearing more than five times as much as those named least often. A somewhat narrower set of frequencies for those topics deemed “important” (only ranging from 18% to 68%, rather than 13% to 77% for “interesting”) suggests a lack of consensus about which topics in the program mattered most. The only session that was mentioned as most important by more than half of participants was the hydrology session. Four of the eight sessions were listed among the “most

interesting” by a majority of respondents. Differences within response patterns of the most important topics suggest both the popularity of the topics and illustrate the flatter distribution of “important” sessions.

On the other hand, two of the sessions described elsewhere as having less immediate relevance to the gas development were named as important more often than they were listed as interesting. The first week’s session on “thinking like a scientist” and the third, on community impacts, were deemed “interesting” by only 22.7% and 13.6% of participants, respectively. However, they were described as “most important” by 45.5% and 27.3% of respondents. This suggested that at least some participants do see the value of science process or data interpretation skills and the social sciences; however, it also suggested an opportunity to make these topics more engaging in the future.

The two remaining sessions were each deemed important and interesting by similar proportions of respondents. The final session, on communication skills, was mentioned least often in both cases – about 15% of participants named it as interesting and/or important.

Participants offered relatively consistent explanations of why they felt various topics were interesting or important; several of these explanations overlapped between “interesting” and “important.” The inherent value and applicability of both new information and new skills were mentioned in some comments. The connection between those new things and respondents’ own local context was also noted. Several individuals described topics as covering material they thought was not available (or only available with difficulty) elsewhere. These comments speak to participants’ own goals and agendas upon entering the program, the demand for such a program, and the additional value of locally relevant detail. Language that was used primarily to explain why topics were “most important” echoed responses from elsewhere in the session-by-session formative evaluation. Several participants mentioned quality instruction as a driver of interesting topics. Others noted the strategies for *how* a topic was presented – particularly hands-on activities, visual materials, and discussion opportunities. Several described their “most important” topic(s) as the reason(s) they chose to participate in the program. These comments suggested (and strengthened other findings on) the successful diversity of topics and activities in the pilot cycle.

Explanations that were primarily used to discuss the *importance* of topics mainly dealt with the future applicability of that topic. These comments ranged from the abstract (appreciating one’s greater understanding of complex systems or risk, for instance) to the highly concrete (as with how session content would inform one’s future decision-making as a landowner or homeowner). Other participants articulated a more general value, but still did so explicitly, stating that a topic was important because it would have an impact on their own or their family’s way of life. Still others felt that their “most important” topics were things they felt they could (or should) share with others.

[Recommendations for program improvement](#)

Most participants offered feedback on how to improve the program. Sixteen of 22 respondents offered constructive criticism when asked, “What should the instructors know about how to make this program better in the future?” Fourteen also did so when asked, “If you were in charge of this program, what would you do differently? Why?” (These comments are reproduced in full below, on page 8.) A number of themes emerged across these two sets of comments, suggesting a group of specific suggestions for program improvement:

- Some topics require more time or attention

- Demand for non-lecture experiences
- Advice for instructors

Summary of end-of-pilot findings

Overall, participants had relatively strong agreement that the program served as good preparation for the knowledge and skills at the core of program outcomes. Knowledge- and understanding-related items tended to receive higher ratings than skill-related items. There was slightly more consensus among participants about which program topics were most important than about which were most interesting. Engineering, geology, and hydrology were often named as being both interesting and important; community impacts and “constructive conversations” were not. When participants explained why they valued a topic, they tended to describe it in terms of applicability to their own interests, experiences, and needs outside the program. Specific suggestions for program improvement fell into a few main categories of action:

- Increased time for or access to more detailed information;
- Clearer explanation of the relevance of topics, both to one another and in participants’ post-program lives;
- Increased opportunity to both witness and participate in dialogue;
- Improvement of instructors’ preparation for sessions and engagement with participants, including preparing instructors to work with adult free-choice learners.

Community Conversations

Project team members from the Penn State University School of Theatre developed a series of “community conversation” events – featuring theatrical performances, expert scientists, and audience / community dialogue – about natural gas drilling and the Marcellus Shale gas play. A formative evaluation of the first such community conversation event addressed several questions related to the structure of the events: the presence or absence of a “balance” between science content, engagement with art, and community dialogue; audience members’ perceptions about the effectiveness of these three elements; and which moments (if any) may have garnered particularly strong short-term reactions from audience members. The formative evaluation addressed several questions:

- To what extent and in what ways did audience members (and performers, and scientists) find that the structure of the “Community Conversations” event:
 - Is effective at communicating science content?
 - Is effective at using art to highlight the complexity of gas drilling-related issues?
 - Is effective at fostering civil dialogue on gas drilling-related issues? (That is, do audience members report or indicate openness to dialogue?)
 - Demonstrates a “balance” between engagement with art and with science?
- What aspects of the “Community Conversations” event, if any, garnered particularly strong short-term reactions from audience members?

As above, this section presents only the key findings and takeaways from the formative phase to avoid redundancy in describing summative evaluation. The full formative evaluation report for

Community Conversations can be found online: [http://informal.science.org/evaluation/ic-000-000-007-629/Marcellus Matters EASE Community Conversations Formative Evaluation](http://informal.science.org/evaluation/ic-000-000-007-629/Marcellus_Matters_EASE_Community_Conversations_Formative_Evaluation)

Audience feedback supported the structure of the program across these questions

Audience members noted, and had positive reactions to, the multiple elements of the event and how they worked in combination. Comments also suggested that audience members valued the interplay of art, science and dialogue. The former was seen as a novel way of creating safe space for the latter, while the presence of “real scientists” lent the event credibility as a source of factual information about complex issues.

Audience members’ interests indicate a strong interest in the elements of these events

Many respondents indicated their interest in and need for more factual information related to Marcellus shale; others mentioned how rarely they encountered opportunities for civil dialogue around gas drilling-related issues. Together, these two types of comment suggest that people communities served by this program are seeking ways to meet their dual needs – for more information and more conversation – around Marcellus shale.

Findings suggested a need for caution or revision as the program moves forward

The audience’s stated interest in factual information, coupled with the acceptance of several pieces of deliberate (and unchallenged) misinformation during the plays indicates audience members’ high level of trust in the scientific expertise of the program team. In its first pilot iteration, at least, it seemed that audience members believed there to be more, and more accurate, science content than was actually present. This misalignment highlights both an opportunity and an obligation for the program team to more diligently present accurate science content and dispel misconceptions – both those presented in the plays and those which arise during the dialogue portion of future events.

Team Communication Study

In early 2014, the Lifelong Learning Group conducted a series of semi-structured interviews (under a quasi-ethnographic research design) with members of the Marcellus Matters: EASE project team and community members who had participated in at least one kind of Marcellus Matters programming. While intended as an exploratory effort, rather than an evaluative one, this study was undertaken at the request of the project team to articulate perceived strengths and weaknesses in the project’s overall communication strategy, as well as to support future planning and professional development. The purpose of this study was to document and analyze the communication strategies used in developing and delivering community programming related to environmental science. Researchers compared perceptions of communication strategies among members of the project team to perceptions of the same strategies among community members. The key findings summarized below reflect those with particular relevance to the discussion at the team’s subsequent communication workshop (February 28, 2014), and they summarize interviews with a total of six team members and five community members.

Reasons for Participation

In both the team and community interviews, respondents were asked to describe their overall reasons for participating in Marcellus EASE. Importantly, each respondent group showed near consensus, and the difference between groups suggests a relationship between a service (on the part of the University team) and a need (on the part of the community members) that is consistent with each group's own articulated motivations.

Team members repeatedly framed their participation as an opportunity to help people or meet a need.

Of the team members interviewed, most also cited relevant personal or professional experience. Half of the team interviewees commented that the project offered the opportunity for interdisciplinary collaboration and posed an interesting or fun intellectual challenge. The importance of the issue and science literacy more broadly came up in other parts of the interview for most of the team respondents, but it was not usually cited as the primary reason for becoming involved.

Community members occasionally cited personal or professional interest in gas development or the general importance of the issue, but the key reason for interviewees' involvement was getting more information about an issue they acknowledged as complex.

Although interviewees perceived a great deal of range in community participants' existing knowledge, even participants who knew a great deal about gas development considered the program a learning opportunity. Notably, they defined this opportunity in terms of both unfamiliar facets of the issue and different ways to interpret available information.

Program approach and content

Both the team and community participants were also asked about how Marcellus EASE approached bringing programs to adult learners in rural communities. While team members were asked to consider their own work in relation to the project more broadly, community participants were simply asked to think about the overall tone of the programs they attended.

When talking about their own programs, team members tended to focus on their personal efforts—something that may have been less visible or more difficult to articulate about others' offerings.

Although the specifics of their descriptions varied, respondents' discussions of their own programs tended to focus on building trust and demonstrating respect for local stories. Meanwhile, their discussions of the project in general (i.e. course modules and events developed by others) mainly related to science literacy and presenting the larger issue of shale gas development from a range of disciplinary perspectives.

Community members for the most part saw the programs they attended as informative, politically neutral, and pleasant, and several emphasized the importance of being able to approach new information critically.

Most also expressed appreciation for the efforts of the Marcellus EASE team, particularly the practical effort of traveling to program sites. While participants spoke mostly positively about their experiences, several observed that attempts to remain neutral could sometimes be misinterpreted in the context of a strongly divisive issue. To address this, they suggested direct discussion of different perspectives on hydraulic fracturing. Finally, while respondents repeatedly complimented the utility of the programs they attended, some felt that people would have asked more questions or discussed issues in more detail but did not want to derail the prepared presentations.

When asked to provide suggestions about content, community members emphasized the need for practical, actionable information, especially resources related to understanding property documents and immediate public health hazards.

Comments about possible additions included discussion of legal issues, practical advice for mitigation and remediation, more information about the complexity of the industry itself, and more advanced information for people who have some basic knowledge about gas development. In describing the most important contextual considerations for their communities, interviewees mentioned the political landscape, participants' personal relationship to and interest in the issue, the literal landscape of the region, the importance of information literacy, and the relationship between economic hardship and the decision to lease. In particular, although interviewees' assessments of local political climates differed, awareness of the extent to which community members felt empowered to affect policy and development was consistently highlighted as central to understanding this issue.

Cumulative Summative Evaluation

Community Science Volunteers

Methods

The summative evaluation of CSV was a census study of all participants in each cohort, and it consisted of a post-program questionnaire designed to measure the success of the program at developing specific content knowledge and skill sets. The instrument included self-reported retrospective pre- and post-levels of understanding related to energy development, self-reported retrospective pre- and post- scores of related to new skills and knowledge, and self-reported activity logs summarizing participant action related to the program. The questionnaire was distributed as a paper-pencil form, then collected by EASE program staff. An abbreviated version of the same measure was also administered by mail several months later. Completed questionnaires were then forwarded to the evaluation team for analysis.

Open-ended responses were coded using emergent categories; where applicable, these coded items were analyzed alongside parallel quantitative items using SPSS. De-identified individual responses to items were analyzed in aggregate across each session, and where possible paired in order to measure change from the pre- to the post- and delayed-post conditions.

As part of regular program activities, participants also took a pre- and post- knowledge assessment; scores from that assessment are described here as paired secondary data that can be triangulated against findings from the evaluation data.

Findings

Following their participation in the CSV program, respondents were asked to rate how well they understood the relationship between Marcellus shale development and each of five affected domains before and after their participation in the program. Analysis of mean showed a significant increase at a $p < .01$ level for all items. To better understand the nature of this group-level positive change, a Cohen's kappa was run to determine the level of agreement between individuals for each item. The item referring to the relationship between Marcellus Shale and the natural environment had the highest level of consistency between respondents with significance at the $p < .05$ level. These data suggest that items that have a greater level of personal relevance (e.g., the risks and possible affordances of where a drilling platform is located) might elicit greater levels of disagreement than items about generally agreed upon topics (e.g., the overall importance of environmental health).

Respondents were also asked to indicate what they gained from the program by rating a series of skill and comprehension items. Analysis of mean showed a significant increase at a $p < .01$ level for all items. Further analysis through a Cohen's kappa showed significant slight to fair levels of group-level consistency on all but three items. The item with the highest level of group agreement ($K = .391$, $p < .01$), significant at the $p < .01$ level, was how well respondents felt they understood how to talk to people who agreed with them on a "hot topic". Interestingly, responses to the item about talking with people who disagreed on a "hot topic" were less consistent ($K = .210$, $p < .01$). The mean scores for this item did increase, which could indicate that though respondents at the group level did generally feel more prepared to talk with people who disagreed with them, the extent of this change was not predictable or unanimous. Moreover, the post-program score for talking with

people who disagreed (M=4.96) was only marginally higher than the pre-program score for talking with people who did agree (M=4.76).

In the delay condition (several months after their completion of the CSV course), participants were asked to answer the same two batteries of questions in relation to their post-program understanding, knowledge, and skills. In examining respondent data for both sets of ratings, no items showed significant deterioration of learning over time; these data suggest that sustained participation in the program not only contributed to learning gains, but also supported sustained understanding, knowledge, and skill for the adult learners who completed the course.

As part of the program-administered pre- and post- assessments, respondents were also asked a series of questions pertaining to their level or trust in various groups, as well as their level of belief in different statements about the Marcellus Shale development. Mean values were calculated for each item on both pre- and post- tests. These scores were compared with a t-test to determine if the change in mean score from pre- to post- was significant.

Respondents felt less negative about items related to shale gas development (e.g., “I believe shale gas drilling will ruin our rural landscape” and “I have less trust in the natural gas industry and science institutions and more trust in environmental groups”) following their participation in the program. In response to the statement “I believe that shale gas drilling will contaminate my drinking water” respondents reported significantly less agreement ($p < .01$) after the program (M=1.89) compared to before the program (M=2.31). This was also true for the negative statement that shale gas drilling would “ruin our natural landscape” to which respondents significantly disagreed ($p < .01$) more after the program (M=2.85) compared to before the program (M=3.11). These data could indicate that respondents gained awareness of how shale gas drilling works, and their fears about contamination or the ruination of the landscape were lessened due to what they had learned. Respondents also felt more capable of discerning the credentials of experts ($p < .05$) with a mean rating significantly lower before the program (M=2.92) compared to after the program (M=3.73). However, respondents did not significantly change level of trust in the media reporting about Marcellus Shale, that Marcellus Shale development would improve their community economically, that their cost of living has increased due to Marcellus Shale development, or that the benefits of the Marcellus Shale development outweighs the costs. This shows that while respondents’ fears (e.g., about drinking water or crime) lessened, their trust in the economic benefits of the Marcellus Shale development were not greatly changed. Cohen’s kappa showed that respondents were significantly consistent ($p < .01$) in how they rated their trust on all items except for their level of belief in their ability to evaluate the credentials of an expert ($K = -.02$, $p = .81$).

Program directors collected pre- and post- questionnaires to collect information on what participants learned as a result of the Citizen Science program. Examination of the results from these pre- and the post- scores across the counties showed that the total scores of participants generally increased, but some questions were more frequently missed than others, and participants showed some variation in score change by county. For example, Clearfield County had the most instances of decreased scores between the pre- and the post- exams, with 6 questions having fewer people answering correctly on the post exam compared to the pre exam; meanwhile, Lycoming County had the fewest cases of decreased correct responses with only a 4.3% decrease for only one question.

Several of the questions seemed to be more difficult than others, as evidenced by lower correct response rates on the post- exam. The counties’ having differing results when comparing pre- and post- scores could indicate differences between preferred learning styles, the types of participants

involved, or other environmental factors that would affect how much people learned from the program. However, a few of the questions had at least three counties with lower percentages of correct scores on the post- exam compared to the pre- exam scores. The target concepts covered by these questions included the assessment of ability to read a plot, facts about the time it takes to drill, identification of social influences, and federal funding of energy. For example, a question that evaluated participants' ability to analyze a graph ("According to the plot, about how many chickens did the United States have in 2010?") had the most number of counties selecting the incorrect answer on the post assessment. Possible explanations for these disparities in pre- and post-assessment scores could be difficulty with the questions themselves, variation in the content presented, and/or variation in teaching techniques among presenters.

Part of the post- program data collection included asking respondents to describe activities they had taken part in outside of the program that pertained to the Marcellus Ease development or shale gas drilling. Participants were asked to record these activities directly following the program and also after a delayed period of time. The types of activities they could list as having participated in included Personal, Community, and Interpersonal domains, with an option to list any other activities in which they had participated. Respondents were also asked to select the number of times they participated in each activity: 1-2, 3-5, or 6+ times. Qualitative analysis of the activity logs from respondents showed several trends. Broadly, respondents reported fewer activities performed on the delay form than the post form.

Items listed in the "Other" category included activities such as looking into starting a dialogue in their county, as well as more abstract outcomes like improved outlooks and greater open-mindedness. Community-related activities included contacting legislators, making presentations to interested groups, and participating in various community organizations and events (e.g., "spoke at borough council about impact fee funds"). Respondents also listed continued research, reading more articles on shale gas development, and utilizing resources from the classroom. The activities listed show the respondents report actively seeking out information and continued education. When asked to report on their Interpersonal activities respondents listed activities that included engaging their family, friends, coworkers, or neighbors in conversations about shale gas development.

The most frequent category on the immediate post response was Personal activities, with the cohorts participating 3.34 times more on average than in any of the other categories. The Personal activity category was also the most frequent among the delay responses. The second most frequent category was Interpersonal activities, followed by the Community category. Respondents used the "Other" category half as often as the Personal, Interpersonal, or Community categories. When asked to report on their activities in the delay condition (several months after the program), respondents on average recorded activities in the Personal category 2.92 times more than they recorded any of the other types of activities.

For both the post and the delay activity logs, the most used category was the Personal category, followed by Interpersonal activities, then Community activities, and finally, others supplied by respondents. Participants tended to report frequencies of 3-5 times and 6+ times for Personal activities than for the other three activity categories; meanwhile, activities in the "Other" category were much more likely to have people listing an activity in the 1-2 times category than either of the other time frequencies. Both high- and low-frequency activities for individuals appear to be consistent with the overall representation of those activities in the larger group; that is, Personal activities were both the most common type of post-program action across all participants and the most common action by most individual participants.

Conclusions

Overall, the multi-year process of developing, implementing, and refining the CSV program for adults in rural communities affected by Marcellus shale gas development showed several important indicators of success:

- Gains in self-reported knowledge of relevant science content
- Gains in demonstrated knowledge about shale gas development and ability to analyze argumentation
- Gains in self-reported confidence about engaging with science and participating in civil dialogue
- Concrete descriptors of relevant use and sharing of relevant scientific information and/or community action

Although secondary data indicated that gains in specific science content knowledge varied from county to county, in general the program appears to have been effective at cultivating increased knowledge of gas-drilling related science content, particularly in relation to how shale gas drilling works (i.e., the process of extraction), and this was especially strong for participants in Lycoming County. Secondary data also indicated that after participating in the program, community members tended to feel less negatively about some of the impacts of shale gas development, although their opinions about economic effects of shale gas development did not appear to change.

In addition, participant data suggested that the program helped people feel more capable of holding constructive conversations with those who agreed *and* disagreed with their perspectives, as well as more capable of sharing scientific information with peers. Other areas of growth included understanding what factual means and how science is conducted, understanding the difference between causation and correlation, and understanding how to find trustworthy sources of information. Additionally, participants felt more prepared to distinguish between bias, opinion, and facts in media reporting and recognized the complexity in decision-making about energy choices.

Importantly, participants in the CSV program also indicated that they made informal use of and/or shared information about shale gas development in their communities. As part of these forms of extension, people were most likely to participate in activities that furthered their own understanding (e.g., applying critical science literacy skills) and/or engaging those around them (e.g., attempting to open dialogue with neighbors). Moreover, reflections from project team members suggest that participants' activities and intentions may have extended even beyond what they articulated themselves, as evidenced by the documented formation of local affinity groups and anecdotal use of project resources. Finally, the CSV program was observed to result in the emergent outcomes of making university faculty more visible and accessible as resources for community members and supporting the sustained enthusiasm and momentum of key individuals in participating communities.

Community Conversations

Methods

In summative evaluation, audience members were asked to complete a short written questionnaire at the end of each event, and the instrument was described to audience members by data collectors while being distributed.

During the formative stage of evaluation, a slightly longer version of the feedback form was used to help the team gather input from audiences that could directly inform the structure and content of the program. Where items matched on the summative stage instrument, data from the formative stage are included here for comparison over time.

Beginning with the October 2012 event, all Marcellus Matters team members who were present (including performers, scientists, and project coordinators) also completed open-ended written reflections in the days following the event. These reflections were analyzed inductively in order to identify key areas of consensus or disagreement and other patterns as they emerged in the text. As part of formative evaluation, these data were used to help the team adjust their approach in real time; this summative evaluation report uses the data to map success and change across the life of the project.

Findings from Audience Data

Data for summative evaluation were collected at each of five events from a total of 64 adult respondents. The largest audience was for the October 2012 event (18 people), while the smallest audience was for the May 2014 event (6 people).

When asked what made them want to attend the Community Conversations events, two-thirds of audience members reported an interest in learning more (66% of respondents). Only slightly less frequently, audience members (63%) indicated that they were interested in how Marcellus shale relates to the environment. About half of respondents reported that they were interested in how Marcellus shale relates to the economy, and 41% noted a specific interest in how Marcellus shale relates to their property. Just under a quarter of respondents reported an existing interest in theatrical performances. Figure 1 compares these interests at the group level across events.

Audience members were also asked to rate their level of agreement with a series of statements related to civil dialogue around shale gas development. While there was majority agreement with each statement, the strength of respondents' agreement varied with each (see Figure 2 and Table 2). At the group level, respondents indicated the strongest agreement with statements valuing others' views. For example, the statement with the highest mean agreement rating was "I believe I could learn from what other people have to say" (mean rating 6.24, with 81% of responses indicating strong agreement), and the second highest mean agreement was with the statement "I want to hear what other people have to say" (mean 5.90, with 67% strong agreement).

Meanwhile, respondents were less enthusiastic about actively contributing their own perspectives: the statement with weakest agreement at the group level was "I want to share my opinions with others" (mean rating 4.97 and 41% of responses indicating strong agreement). While constructive dialogue depends on acknowledging the complexity of an issue and uncertainty on some points, the relative hesitation of some audience members to contribute their own perspectives may mean that some audiences could benefit from additional encouragement to participate.

Given that respondents participated in different experiences (including performances of different scripts) with sometimes very different audience dynamics, it is also illustrative to examine ratings for each individual event (Table 3). While the small and varying audience sizes limit the power of quantitative analyses of these data, the variation in responses across events does suggest some differences in the overall dynamic of each event.

For example, respondents at the last event in the series (May 2014) gave the highest mean ratings on items pertaining to diversity of perspective, with lower interest in sharing a specific perspective; this is consistent with the event dialogue itself, in which a small group of participants raised questions on a wide range of safety issues. In contrast, the second-to-last event (November 2013), which included a much more contentious dialogue involving an argument between activists, received the highest rating for certainty about respondents' own points of view. Finally, the second event (October 2012) received the highest mean agreement rating for the desire to listen to others *and* the desire to share personal opinions; this data point echoes team members' perceptions that the audience seemed particularly receptive to the program and accompanying dialogue.

People who attended the events were also asked to comment on their reactions to the event itself. Fourteen audience members responded to an item asking them to describe anything that had surprised them about the event; three left additional comments that did not respond directly to this item. For the purpose of analysis, all written responses were coded together to reflect qualitative feedback from 16 individuals.

The most frequent theme within these comments (5 respondents) pertained to the quality of interactions at the event; specifically, they referred to a positive tone or dynamic as part of the dialogue component. The next most frequent categories of response (with 3 respondents each) concerned the science of hydraulic fracturing or were general positive comments. Another two respondents voiced a specific concern related to shale gas development; in one case this related to environmental monitoring, and in the other it related to economic growth. Rarer responses (1 respondent each) pertained to the quality of the performance, the quality of the discussion segment (in terms of depth and content), and career opportunities. In triangulation, the data suggest while the specific circumstances of each event varied, the overall program structure was mostly successful in supporting space for positive dialogue.

Team Reflections

Describing the audience

The first thing team members were asked to comment on after each event was the audience. While team members were fairly consistent in using demographic descriptors like age and sex across events, other areas of description were more or less emphasized at different events. For example, proportionally more team members noted attendees' connections to the project (i.e., previous participation in project elements, especially the Community Science Volunteers course) at earlier events. At later events, which did not seem to include such heavy attendance from previous project participants, team members were more likely to comment on attendees' knowledge about and specific interests in energy issues. While comments about the number of people and whether or not attendees were from the local community were consistently included in team members' logs, audience size seemed to grow as a concern whereas observations about attendees' home communities seemed to decrease by the last event. These observations suggest that across events, audience members' prior knowledge of and interest in gas development likely contributed to their perceptions of the events. In addition, both the heavy presence of "known" participants early on and the relatively small audiences in later events underscored persistent challenges in publicity efforts related to Marcellus Matters activities in general, and the performance events in particular.

Audience engagement: perceived success

Team members were also asked to weigh in on what they thought was the most engaging part of each event. Although at least one person at each event noted overall success, with “both parts” engaging the audience in different ways, this was more common at the October 2012 and June 2013 events than at the November 2013 and May 2014 events.

After the October event, two-thirds of the team members present commented that the performance and dialogue segments were equally engaging, with the remaining members highlighting the dialogue specifically. The June event showed less agreement among team members, with comments divided among the performance segment, the dialogue segment, and “both.” However, in both the November and May events, the majority of the team highlighted the dialogue segment as most engaging. Praise for the performance was weakest overall: it was generally “appreciated” but was rarely highlighted. One possible reason for this is that the performance segment was consistently workshopped and prepared in advance, whereas dialogue was emergent in the context of each location, and so may have been more top-of-mind. Although certain components solidified and some team members were present for every event, there was also a great deal of variation in who was present. Therefore, as with the formative evaluation, the persistence of team members’ individual agendas, understandings of the project, and criteria for project success were often clearer than the adoption of a unified set of goals and indicators across the whole team.

When asked if they noticed any unexpected audience reactions, team members responded to early events by focusing on similar topics; however, they sometimes reached opposing conclusions. Overall, team recall of surprising moments tended to concern audience engagement with the performance, but responses differed in degree: while some noted surprise at how actively the audience was engaged, others expected more engagement than they observed. Similarly, team members seemed to have divergent expectations about humor in the early performances, with some individuals noting both more open laughter than expected, and others noting less of the same. As above, these differences likely reflect the different approaches to performances that emerged throughout the life of the project.

In reflections from the November 2013 event, nearly all team members expressed surprise at the dynamic of the dialogue event. However, this seemed more specific to disruptive audience members than the structure of the event itself, as evidenced by team observations that the audience appeared “much more hostile than we are used to” (Team Member Log). Other triangulated event data suggested that this was indeed a function of context, particularly given that a majority of team members indicated that they encountered nothing unexpected at the last event (May 2014).

Conclusions

Overall, the long-term collaborative process of developing, implementing, and refining the Community Conversations event structure demonstrated several major affordances of performance and narrative in fostering discussion about energy-related issues: piquing participants’ interest in science, identifying and honoring emotional complexity in decision-making about energy, and fostering opportunities for respectful conversation between people with a range of perspectives.

Although at various points Community Conversations events emphasized either the inclusion of accurate artistic representations of local concerns *or* accurate scientific content, the team learned over time how to demonstrate balance between these twin concerns. Moving too strongly in the direction of either was perceived as undercutting the other, but in recognizing that these issues

could be effectively framed as intertwined—not necessarily opposed—the team was able to refine the balance of artistic and scientific elements in a way that authentically highlighted the emotional and sociopolitical complexity of shale gas development without perpetuating scientific misconceptions. In considering what touchpoints seemed especially compelling, team reflections identified risk, competing perspectives, and trust or uncertainty as themes that seemed to resonate most with audiences.

Additionally, participant responses suggest that while the immediate reactions to each event varied according to audience concerns and the content of the event, the overall program structure was mostly successful in supporting space for positive dialogue. Notably, after they participated in Community Conversations, respondents generally indicated strong agreement with statements valuing others' views; meanwhile, their ratings were lowest for statements related to sharing their own perspectives. Meanwhile, two-thirds of respondents framed their interest in the event as connected to wanting to learn more. Taken together, these data suggest that while Community Conversations were effective at activating participant interest and providing a comfortable space to engage in complex discussions, some participants may have lacked firm stances and/or confidence in their own knowledge going into the experience.

Finally, an important takeaway from Community Conversations was other project team members' greater awareness of the affordances of communication theory and the power of personal narrative in public communication about science, both in the EASE project and beyond it. In addition to the programmatic elements of Community Conversations, the program team's contributions to the Community Science Volunteers (CSV) course's discussions of communication, a team communication workshop, and the MarcellusByDesign games underscored the project's legacy as an innovative collaboration between physical and natural sciences, social sciences, and performing arts.

MarcellusByDesign

Methods

Summative evaluation of MarcellusByDesign was a census study; all participants in the workshops were invited to complete a post-event questionnaire. For the first MarcellusByDesign event, the project team gathered formative feedback, while members of the evaluation team conducted semi-structured observation of the event and subsequently debriefed with the program team. Semi-structured observation was repeated by the evaluation team at the second event in order to track the changes made in response to feedback, as well as variation in responses from participants. Following the first workshop, all participants in the remaining MarcellusByDesign events completed a revised questionnaire focused on their experience of the program and their takeaways from it.

Findings

In total, there were seven respondents to a programmatic questionnaire administered by the team at the initial MarcellusByDesign event; evaluation data included 20 additional respondents who responded to a summative questionnaire at the four subsequent events in Tioga, Lycoming, Indiana, and Clearfield counties.⁴

⁴The overall audience at the first MarcellusByDesign included approximately 35 adult participants. However, because the event was immediately followed by a community planning meeting, the response rate at this

As part of program activities, the MarcellusByDesign, team used a short questionnaire at the first event to document community participants' responses to the experience. This instrument was intended to gather general feedback about the workshop activities, and where possible, provide some additional information about respondents' perception of main messages. From these data, several key observations rose to the top in considering the first planning workshop, which took place in Sullivan County. As expected, hands-on activities and opportunities for discussion were high points, and facilitators found them most effective when community members were explicitly given the chance to share their knowledge of the area. Although this seemed to be true for a photo activity, in which participants looked at photos of viewsheds and various community landmarks and ranked their familiarity and cultural importance, it was particularly prominent for the feltboard activity and the mapping exercise, which invited participants to attempt to place a well pad within Pennsylvania regulations and landowner desires, and to name areas of local importance, respectively. Although some participants seemed to view any discussion of mitigation or remediation efforts as unacceptable (per a strong conviction that drilling should simply be prevented), others found important entry points that they could connect to their personal interests, specifically when topics related to conservation of natural and cultural resources and potential effects on landowners. While some logistical concerns like timing and the structure of a photo activity were mentioned by both participants and facilitators, and there was some pushback in service of political activism, these minor challenges presented tangible and approachable opportunities to improve future program offerings and bolster authentic community dialogue. On the whole, the overall tone of the workshop could be described as positive and productive, and comments from both participants and facilitators were largely consistent with the broader goals of the Marcellus EASE project.

During the presentation segments of the workshop, participants' observable reactions of surprise or approval were particularly evident in moments where facilitators provided visual examples or mock-ups of mitigation efforts that showed strong before-to-after contrast. In addition, there were more instances of whispering and side talking in the audience in moments where facilitators deployed a strategy of naming something they thought participants would identify as important (e.g., leasing rights, presence of big box stores, trucks from the gas companies, etc.); whether this reaction appeared positive or negative tended to vary depending on tone and topic.

An important high point of the evening was the breakout mapping activity in which participants located important community sites on large maps in conversation with facilitators. Several participants expressed that they had a great deal of information to share (e.g., "I could do that all day"). Importantly, this was recognized in the facilitator reflections described above, as in the comment "Everyone was so eager to share their personal stories and their 'places' with us."

Although both participants and project personnel noted that people who had attended the Community Science Volunteers class sequence had already done the feltboard planning activity (due to its being part of the course module on land use), that breakout session also yielded some fruitful conversations. Of special note was a shift in the focus of some small group conversations: whereas some participants initially described any development of impact as absolutely unacceptable (and therefore did not want to discuss mitigation efforts), discussions began to move to strategies for minimal impact as the activity progressed. This suggests important headway toward reaching the overarching project goal of building civil dialogue.

event was lower than anticipated. Despite this, additional information on the participants who did not complete a questionnaire may be gleaned from observation data.

Observation data also underscored that the emotional facets of gas development could function either as barriers or as entry points. While some participants were resistant to the planning concepts because they wanted more emphasis placed on their own experiential knowledge and personal concerns, others seemed to find greater stake in mitigation when planning efforts were contextualized by residents' prioritized viewsheds or cultural resources. During the feltboard planning activity, the provided distance measures seemed to be an important point of recognition activity pieces for some participants. Among the exchanges observed by evaluators, the measures also highlighted the personal aspects of gas development: the people who chose the distance measures first went straight to discussing their well pads' proximity to homes. Although the photo activity seemed difficult for some participants, facilitators hypothesized that this could be improved simply by reducing the number of photos to choose from. Despite what appeared to be some logistical difficulty in allocating the photos across ten categories, both the photo activity and the mapping activity seemed to result in participants' sharing a great deal of information about specific community resources and priorities with facilitators.

Program Refinement and Sustainability

For the remaining four MarcellusByDesign events, the program consistently included presentation of student research applications to local issues related to shale gas development. As the online resources associated with MarcellusByDesign became more fully elaborated and complete, additional program elements related to the use of those resources, particularly student projects and games (such as one based on the analog felt board experience), were added to the program structure.

Rooted in formative feedback and strategic planning, these programmatic changes were largely successful, as evidenced by both audience data from summative questionnaires and semi-structured observation of the second workshop event. In counties where there was a local "champion" for the project (i.e., someone who would enthusiastically advocate for participation and share knowledge with others), this factor seemed to foster a supportive and interested audience. For example, personal invitations from and the endorsement of a Tioga County planner were mentioned by multiple participants aloud and in writing. In addition, that planner's direct call to consider students' project work in the timely efforts to update county planning documents seemed to make the students' ideas seem possible in the immediate future.

While the choice to include fewer hands-on breakout activities in the remaining counties meant that there was less structured knowledge sharing from community participants than there was in Sullivan County, it also meant that students were able to explain their work in more depth, and that both community members and students had the opportunity to discuss specific interest areas in more concrete and focused ways during the question and answer session.

In the initial MarcellusByDesign program, presenting local solutions while respecting community members' own understandings of place was mentioned as a challenge by a few students, as well as a few participants. After restructuring the program, the students seemed to have strongly cohesive strategies of employing user personas, concrete visual and emotional references to history, and comparisons to their own sense of meaning and place. These strategies seemed very effective in personalizing their projects and making them seem relevant for community members, in that comments of this type were commonly met with nodding, smiling, and positive side talk from participants.

Audience Expectations and Needs

Audience data suggest that respondents did not seem to have a specific, concrete sense of what the MarcellusByDesign program would include, but they were mostly unified in saying that the overall quality and depth of the event exceeded their expectations. In describing their expectations for MarcellusByDesign events, participants most frequently anticipated hearing general information about shale gas development (5 respondents). The next most common expectations related to the tone, with three respondents anticipating a *more* formal presentation and one respondent expecting a *less* formal presentation. Another prominent theme was the availability of practical resources (3 respondents). Others were more uncertain, noting either that they did not know what to expect, or general ideas based on what they had heard or read (e.g., cosmetic fixes, “Follow up activities related to issues brought out in the previous 10-week sessions on Marcellus development,” or “local info”).

When asked to compare the program to their expectations, respondents (n=20) primarily offered general positive comments (e.g., “The program was great”). Strong secondary themes included comments about the content (5 respondents) and/or depth (4 respondents). For example, one respondent commented that the program included “More theoretical analyses/cultural resources” than expected, and another noted that “Many more areas of impact from shale gas development were presented” (Summative Evaluation Questionnaires). In contrast, one respondent commented that there was less depth to the program than expected. Meanwhile, a few respondents commented on the potential to apply what they had heard, and two respondents felt that the program was less formal than they anticipated.

Audience Takeaways and Experiences

When participants were asked to describe what was most interesting to them about MarcellusByDesign events, the most frequent categories of response pertained to a specific local application or treatment and novel approaches to decision-making about land use. Other prominent interest areas were the inclusion of academic studies and the science of planning for land use and introduction to the MarcellusByDesign website. One respondent remarked on the connection between invasive species and shale gas development.

Participants were also asked to share anything described in the program that was something they already knew. Repeated answers related to Act 13, riparian zones and buffers, water management, and the complexity of planning for land use. Other individual responses related to the “design of a wellpad,” “the visual narrative of architecture,” gardening, and habitat impacts.

When asked if anything they heard in the MarcellusByDesign program contradicted what they already heard, respondents were unanimous in reporting that nothing did. As one respondent wrote, “I don't think anything contradicted what I have heard--I just heard much more.” Participants were also invited to share any potential applications for what they had seen in the MarcellusByDesign program. Among their comments, use of the new MarcellusByDesign website was most prominent, with nearly half of respondents reporting intention to use the online resources. A third of respondents reported sharing information, both through personal discussions and through local and regional publications. Importantly, two respondents indicated specific, immediate intention to use students’ design suggestions in their town planning documents. Individual comments related to enlarging a town garden and thinking about “how I can use my engineering design skills combined with geographical data analysis to make better decisions.”

Specific to the well placement exercise, respondents answered three scaled items related to the learning goals of the activity: understanding complexity and understanding the particular concerns of a variety of perspectives. Of these items, participants moderately agreed that they had observed variable outcomes in relation to their land use decisions. In addition, they indicated slight agreement that they could understand perspectives other than their own, as well as the potential ramifications of gas development in their own lives.

In thinking about the general experience of MarcellusByDesign, participants were invited to rate their level of agreement with several statements about the social dynamic of the event (on a scale where 1 represented “Not at All” and 7 represented “Completely”). Respondents (n=16) reported slight to moderate agreement that they felt comfortable sharing their perspectives and that their voices were heard (Table 2). Perhaps relatedly, participants reported slight disagreement that their perspectives were very different than those of other attendees.

Taken together, these data suggest that while audience members’ entry points and major interest areas varied a great deal, participants were largely well-informed about key issues touching their lives and communities, yet the major appeal of MarcellusByDesign was still closely aligned to the program’s goals of communicating the logic of planning and actionable information to support community involvement.

Conclusions

Overall, the development and implementation of MarcellusByDesign demonstrated efficacy at sharing a relatively unfamiliar academic perspective on issues related to shale gas development with participants in target communities. While the number of participants present at individual events was limited despite the use of many outreach strategies, data from the program suggest that those who participated responded favorably and reported learning new things related to planning for the existing or potential effects of shale gas development in their communities.

Interestingly, the workshop events did vary somewhat from participants’ expectations, in that most did not expect the specific types of content and/or depth of content they observed. In general, participants also agreed that they felt their voices were heard and they were comfortable sharing their perspectives; however, they also reported that they did not feel that their perspectives were particularly different from those of others in attendance. This finding was underscored in respondents’ discussions of their expectations for the events: many participants entered with some specific technical knowledge related to shale gas development, and most did not feel that their entry knowledge and perspectives were contradicted. Notably, most still indicated that they had learned something during the workshop. While this primarily related to specific design solutions or strategies, in some cases, it also related to thinking about community decision-making. For example, in considering the feltboard well placement exercise, audience data illustrated that the activity was effective at helping participants see different rationales for placing wells in specific locations, as well as the effects of placing wells in those locations.

Moreover, program data also suggested that the suite of resources made available to participants through a combination of community planning workshops and the program’s online presence were met with enthusiasm, intention to apply learning to real-world issues, and in a few cases, documented action. In describing possible applications of what they learned from MarcellusByDesign, participants described exploration of the online resources, sharing information with others, and including suggested planning strategies in upcoming community planning conversations. By the end of the project, an important takeaway from MarcellusByDesign was the

recognition of the need to understand community perceptions and needs—and to link that understanding to programming in service of fostering productive dialogue.

In addition to faculty dissemination work and improved relationships with communities and representatives from other academic disciplines, a major success of the MarcellusByDesign program was its team's work toward project sustainability in the form of comprehensive and accessible online resources. In summary, MarcellusByDesign not only supported improved knowledge and accessibility to community planning among its participants, but, through strategic resource development, also stands to continue doing so for interested adult learners for the foreseeable future.

Marcellus Citizen Science Network

An outgrowth of the Community Science Volunteers (CSV) course, the Marcellus Citizen Science Network (MCSN) was a program developed to immerse adult learners in the processes of scientific research. By teaching participants to locate and report orphan and abandoned wells (OAW), the program involved people in data collection that could help mitigate against potential hazards in their communities.

MCSN was structured to include both a workshop element (in which participants learned how to identify potential well locations) and a fieldwork element (in which participants actually attempted to locate wells based on preliminary research). The stated goals of the MCSN program were to engage people in the processes of scientific inquiry, to increase participants' interest in science and energy, to increase participants' knowledge about the science and technology involved in locating OAW, and to support participants in contributing to scientific knowledge in their communities.

In the context of the larger project goal of fostering civil dialogue and involvement in community deliberations about energy, evaluation sought to answer two overarching questions:

- To what extent did the Marcellus Citizen Science Network build participant awareness of science and energy and participant understanding of scientific processes?
- To what extent did the Marcellus Citizen Science Network foster or enhance individual participation in community science efforts?

Methods

The evaluation of MCSN was a census study of all participants at each program event, and it consisted of a post-program questionnaire designed to measure the success of MCSN at developing specific content knowledge and skill sets. The instrument included self-reported retrospective pre- and post-levels of understanding related to energy development, self-reported retrospective pre- and post- scores of related to new skills and knowledge, and a few interest- and experience-related questions to inform the continual development of the program. The questionnaire was distributed as a paper-pencil form, then collected by EASE program staff; completed questionnaires were then forwarded to the evaluation team for analysis.

Open-ended responses were coded using emergent categories; where applicable, these coded items were analyzed alongside parallel quantitative items using SPSS. De-identified individual responses to items were analyzed in aggregate by session-type (i.e., workshops and fieldwork experiences). The creation of separate instruments for workshops and fieldwork meant that each response could

be tied to the specific experience of participating in a workshop or in fieldwork; however, as a result, some individual respondents in the workshop participant group were represented in the fieldwork participant group.

Findings

In total, 51 participants attended an MCSN workshop, and 71 participants attended an MCSN fieldwork experience (with about 25 participants attending both). From this overall pool of participants, 43 individuals responded to an experience questionnaire. Among these, 14 were respondents to a first-phase formative questionnaire administered by the team at the combined workshop and fieldwork experiences. The evaluation data described here includes comparable data from those initial measures, as well as data from 29 respondents who responded to an experience-specific summative questionnaire (i.e., a workshop-related and/or a fieldwork-related instrument) at each subsequent event. For the purposes of analysis, participants in the full-day experiences that took place in phase one were considered to have participated in both a workshop and a fieldwork experience. Of the 29 participants in phase two of the program, five participants attended both a workshop and a fieldwork experience, two participated in a workshop only, and 22 participated in fieldwork only.

While in the first developmental phase of the program the research workshop and fieldwork elements were combined into a single day-long experience, participant feedback indicated that separating document-based research from fieldwork would allow attendees to focus more deeply on their interest areas and create fewer barriers related to scheduling. Therefore, the second phase of MCSN presented several discrete opportunities for participants: workshop experiences, demonstration-based fieldwork experiences (in which a facilitator took participants to a known well site and went to practice documenting it), and exploratory fieldwork experiences (in which a facilitator and participants identified a likely well site and went to investigate it). In addition to these in-person experiences, the program also included the development of online resources which participants could use to document and report OAW to state agencies.

Connections to Other Project Elements

Because the MCSN program began after the other project elements, participants were asked whether they had taken part in any other EASE programs. Among their responses, some participants did indicate that they had attended previous public events related to the Community Conversations (a performance and community dialogue program) and/or MarcellusByDesign (a community planning workshop experience). The most common past interaction with Marcellus EASE was through Community Science Volunteers, an 8-to-10 week course designed to build critical science literacy through exploration of topics related to shale gas development. This finding is unsurprising in light of the general trend toward increased general buy-in for the EASE project among those who had participated in the longer-term experience of Community Science Volunteers, as well as the fact that in several counties, participants had been directly invited to participate in MCSN.

Participant Knowledge and Understanding

After each type of program experience, participants were asked to rate (on a scale where 1 meant “Not well at all” and 7 meant “Very well”) their knowledge and ability related to science skills before their participation and after it. For both workshop experiences and fieldwork experiences, participants reported significant, positive change on every skill and knowledge item. Following

both the research workshops and the fieldwork experiences, the areas in which respondents felt most confident were understanding methods for collecting data and knowing where to find state and local data on OAW; notably, scores showed stronger agreement after fieldwork. The item with the least reported change related to how to record GPS data, which likely reflects participants' existing experience; among those who had participated in fieldwork, nearly all (20 of 23 respondents) reported that they had used a GPS device before participating in the program.

Participant Learning Roles

Because both the workshop and fieldwork experiences included participants recruited through existing community groups, the evaluation team also sought to understand how participants saw their roles in the learning experiences of others. While a very strong majority of participants in both workshops and fieldwork reported that other participants had influenced their individual learning, far fewer saw themselves as having contributed to the learning of others (Table 4s and 5). Even so, more fieldwork participants than workshop participants reported that they had influenced others, particularly in relation to sharing scientific information and making plans to continue their participation.

Participant Confidence and Intention

All participants were also invited to rate their agreement (on a scale where 1 meant "Strongly Disagree" and 5 meant "Strongly Agree") with statements related to their beliefs about community involvement and their levels of confidence about and interest in continuing to contribute to the reporting of OAW. The strongest agreement from participants in both experiences related to the idea that citizens can contribute in important ways to the scientific process of locating OAW (Tables 6 and 7). Despite this, agreement was moderate but less strongly reported for participants' enthusiasm about and confidence in their own personal involvement.

When asked if they had plans to continue the activities they had participated in as part of MCSN, about half of respondents (13 of 21) described some intention to do additional fieldwork. For most who described their plans, the activities they listed mapped directly to places they already went or organizations they were already part of; this suggests that although the number of people at individual program opportunities was sometimes small, the outreach strategy of engaging those who already had some active interest in environmental health and/or existing presence in places likely to have OAW did reach target audiences. For example, a respondent wrote "I would do [more fieldwork] on my friends' farm, where I know the lay out of the land" (Summative Fieldwork Questionnaire). Respondents also framed opportunities as being connected to their existing community efforts: "We have an established group that is interested in creating a database for our county in Ohio. This will require citizens work in the field" (Summative Fieldwork Questionnaire).

Although responses from workshops were limited, four respondents did offer similar intentions related to the background geographical and historical research involved in locating potential well sites. These included comments like "Look at computer research for areas that I hike and fish near" and "research the state game lands located in the NE part of the country" (Summative Workshop Questionnaire). Notably, one respondent did identify a potential leadership role in continued OAW activities, reported that they were "also interested in educating others on this info and the online tools" (Summative Workshop Questionnaire).

Program Sustainability

Both to provide opportunities for iterative refinement and to inform conversations about the sustaining OAW citizen science initiatives beyond the funded grant, participants in MCSN were asked to rate their interest in attending future events (on a scale where 1 meant “Very uninterested” and 5 meant “Very interested”) and to provide feedback about their experiences, as well as potential organizational contacts for outreach. For both experience types, respondents reported moderately strong interest in continuing their participation, with workshop participants (n=6) giving a mean rating of 4.7 (Median: 5; Mode: 5) and fieldwork participants (n=25) giving a mean rating of 4.2 (Median: 4; Mode: 5).

In describing what they felt was most helpful about the MCSN workshop experiences, respondents primarily mentioned visual examples of wells themselves and the process of accurately and thoroughly creating well reports. Areas that they felt could be improved related to logistical details, such as projection equipment, the temperature of the room, and timing. Meanwhile, participants primarily identified the most helpful elements of the fieldwork experience as opportunities to see wells in person and learning experiences related to describing the characteristics and details of wells. Among the aspects of the fieldwork that they felt could be improved, participants focused primarily on the desire for more hands-on practice and the desire for longer experiences. To support deliberation about future program opportunities, a complete list of raw responses is included in Appendix B.

Among the organizations that participants suggested MCSN contact, Sierra Club was listed most frequently (5 respondents), followed by Pennsylvania Senior Environmental Corps groups (3 respondents) and the League of Women Voters (2 respondents). Other suggested contacts included the Indiana County Conservation District, DEP/DCNR, Penn State Geosciences Club, Ohio River Citizens Alliance, and Friends for Environmental Justice.

Conclusions

Overall, the development and implementation of the Marcellus Citizen Science Network demonstrated efficacy at supporting community learning related to science process skills, as well as increasing skill and intention in relation to locating and documenting orphan and abandoned wells. Comments related to the program suggest that in general, those who attended MCSN events responded positively and could identify applicable takeaways from their participation.

More specifically, community members enjoyed participating in scientific processes, and they felt that the program had prepared them to locate OAW. Meanwhile, audience data demonstrate that both the workshop and fieldwork components contributed to significant, positive gains in skills and knowledge. Workshops were most effective at helping participants understand the processes of conducting historical research on OAW and understanding well data, whereas fieldwork experiences helped participants improve technical skills, such as documenting their observations, describing OAW, recording GPS data, and reporting OAW.

Importantly, participants agreed that citizens have a meaningful role to play in gathering scientific data about OAW, and participants’ individual learning and increased confidence suggested that they were well-positioned to begin filling that role. Despite this, their personal commitment to taking action tended to be in the neutral ranges: their individual motivation to participate in efforts around OAW was not as strong as the general sense that locating and documenting well sites was a worthy goal. Even so, participants in both workshops and fieldwork experiences agreed that they

would be interested in participating in additional program sessions in the future. This interest, combined with participants' indications that they primarily saw themselves as learners, rather than in positions to support others' learning, triangulates against findings from other elements of the larger EASE project.

Because the Community Science Volunteers (CSV) course had a strongly didactic orientation *and* that program was the most visible element of EASE for many participants, expectations about the structure and purpose of both MCSN and MarcellusByDesign appeared to have been somewhat influenced by the course. In some ways, this was very supportive: the buy-in that was generated through sustained contact with CSV participants seems to have contributed positively to outreach efforts for MCSN. In approaching MCSN, however, many participants appear to have primarily considered their enthusiasm about hands-on fieldwork experience and increased confidence and skills of within the frame of individual learning, rather than community action. Still, by the end of the EASE project, MCSN program data indicated that workshop and fieldwork experiences were met with enthusiasm, were supportive to community members' skills and knowledge of science processes, and for some, encouraged participants to apply what they had learned.

Meanwhile, an important takeaway for the program team was that MCSN illustrated the value of community contributions to local scientific knowledge. Additionally, the outreach necessary to building MCSN strongly demonstrated the importance of understanding and foregrounding the concerns of individual communities and stakeholder groups, as well as the importance of sustained, relationship-driven communications with participants.

As was also true for other EASE programs, the legacy associated with MCSN included publications and presentations by team members, along with documented community intention to continue the use of program resources. Finally, the development of strategic partnerships and sustainability planning for OAW together have positioned MCSN programming as an important precursor to new opportunities for citizens to engage in the process of locating and reporting OAW that will beyond the EASE grant period.

Conclusions

This evaluation was designed to answer questions emerging from the five goals of the project. To summarize the successes of the project, brief responses to each question are included below.

1. Did participants increase their knowledge of science and engineering related to energy consumption, production, and policy?

Yes. Across activities, participants gained scientific knowledge and engaged in (usually) civil discourse. In particular, the Community Science Volunteers course and MarcellusByDesign events helped introduce participants to new ideas and approaches to the science content and issues related to shale gas development. Meanwhile, both MarcellusByDesign and Community Conversations events served to highlight the complexity of shale gas development through the lens of participants' lived experiences, as well as the concerns germane to individual communities. To build on these other areas, the Marcellus Citizen Science Network improved participants' knowledge of a specific facet of the legacy of energy development, immersed participants in scientific processes, and provided opportunities to practice skills in real-world settings.

2. Did participants build a shared knowledge base on science and energy to empower rural communities in making decisions and managing change?

To some degree. There was shared knowledge within any component. Because of the shifts in the program design, there was no means by which to determine the degree to which communities were empowered. Elements of the program did show anecdotal evidence of making significant change. In connection with MarcellusByDesign, several planning departments have used tools and information from the workshops in developing ideas for their communities. Some participants in the Community Science Volunteers course have continued to discuss energy issues and share their knowledge with others; this has been particularly true for Sullivan County, where past CSV participants organized a regular "breakfast club" and held community events. Meanwhile, Penn State's Theatre department is using the structure developed for the Community Conversations to facilitate science communication across the university. Finally, the Marcellus Citizen Science Network has full support and engagement from the state Department of Environmental Protection (DEP), which is positioned to lead ongoing efforts to document community data in online repositories. These indicators of impact reveal the power of components, and suggest what might have been had the model held true.

3. Did participants apply skills of scientific inquiry and investigation by engaging in community or citizen science?

To some degree. As the components were not cumulative, the range of activity was limited within each of the individual programs. For example, the sustained contact inherent to the Community Science Volunteers course allowed participants for much deeper immersion across the skills, whereas those who participated in the Marcellus Citizen Science Network learned and applied skills in authentic ways. Although these programs had some audience overlap, the changes to the overall project trajectory meant that these connections were not consistent enough to be tracked in a meaningful way.

4. Did participants learn effective strategies for deliberation of complex environmental issues?

Yes. In each of the components, effective strategies were modeled and participants engaged in deliberation to varying degrees. Because of the shift in the program model, the impacts were not cumulative, so there was no tracking of change across activities, yet each component met its desired outcomes. Even in the settings where imported activists were present, the dialogue remained civil as different ideas were expressed. Only in the media following events was inflammatory language used, and never by local citizens who participated in the programs.

5. Was a model of community engagement and capacity building in science and energy created?

To some degree. The changes in the program shifted the focus from a unified program leading to civil discourse and greater engagement, but allowed the program components to each approach the challenge independently. Each component worked, and over the course of the project each component became highly effective on its own, but the overall model did not reach the level of community engagement initially desired. Those involved in the Marcellus Community Volunteers course had a high degree of positive capacity change in science and energy, as did those involved in the Marcellus Citizen Science Network. Participants in the Community Conversations had a strong shift in understanding the complexity of emotions involved in the scientific and environmental issues, and those who attended MarcellusByDesign workshops gained great insights into strategies and considerations for decision-making around the shale gas issue. Across these elements, several key personnel provided some consistency for participants. This allowed for important relationship-building, which in turn enabled individual programs to pivot toward beginning to understand and address local audiences' needs and interests.

Appendix A: Legacy Products

In addition to the outcome achievement experienced by participants, the EASE project resulted in a number of legacy materials and emergent outcomes that reflect ongoing community engagement. These are described for each program element below.

Community Science Volunteers

- The hard-copy notebook from the 10 week course
- Online course that will remain accessible
- Individuals who are now local spokespersons for energy and science in the communities
- Database in the DEP on Orphan Wells

MarcellusByDesign

- An online learning module has been developed and tested.
- Three different data games were created and are available online.
- 33 Presentations on the design projects and the process related to the workshops have been shared.
- 3 Master theses grew out of the research work from the classes working on the workshops.
- 34 undergraduate projects grew out of the research work from the classes working on the workshops.

Community Conversations

- The work around “simplifying, clarifying, and focusing” that drove the process for the project is now being used across many departments within Penn State University.
- The work of the conversations led to insights about teaching empathetic connectivity to scientists.

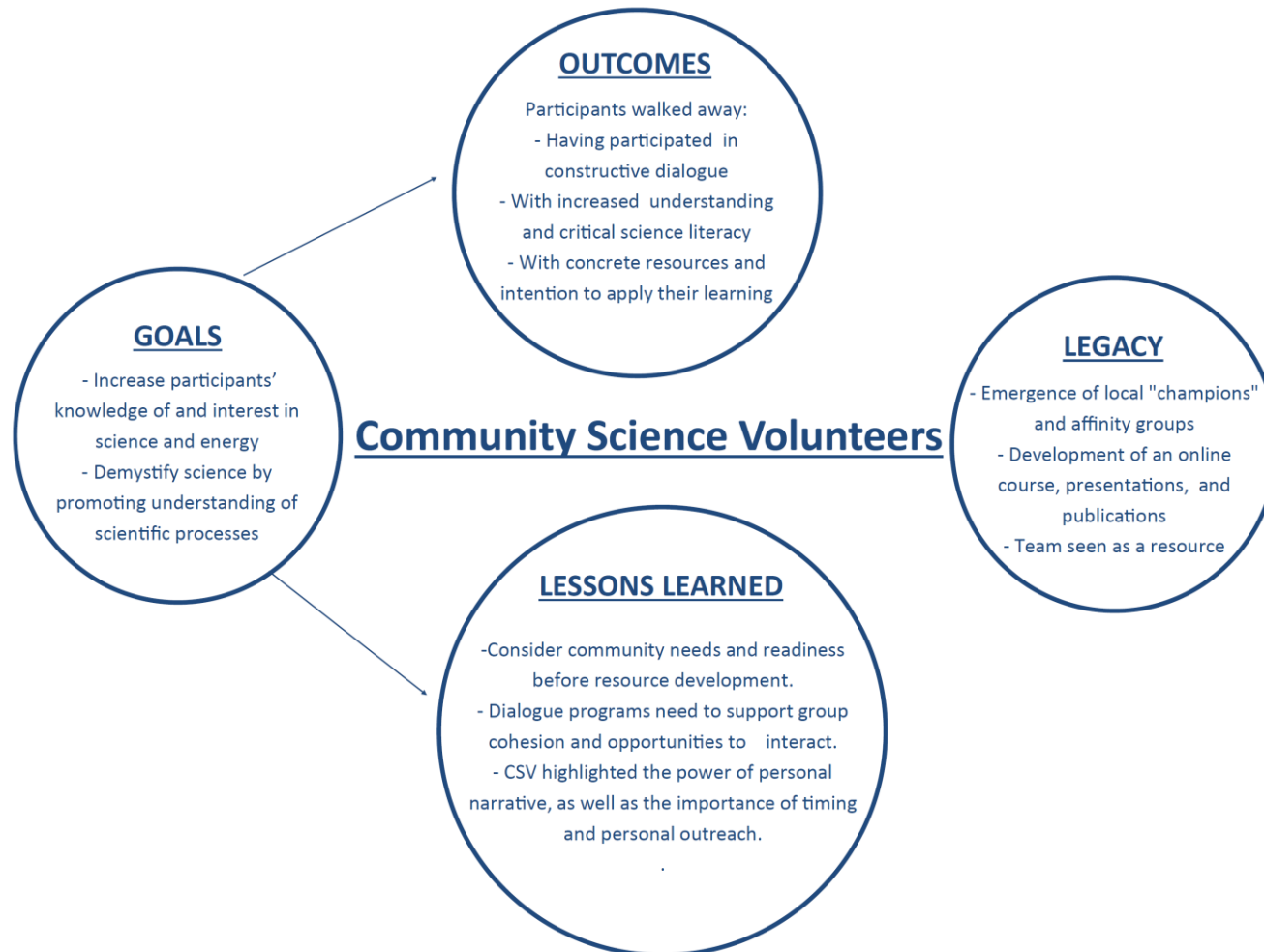
Marcellus Citizen Science Network

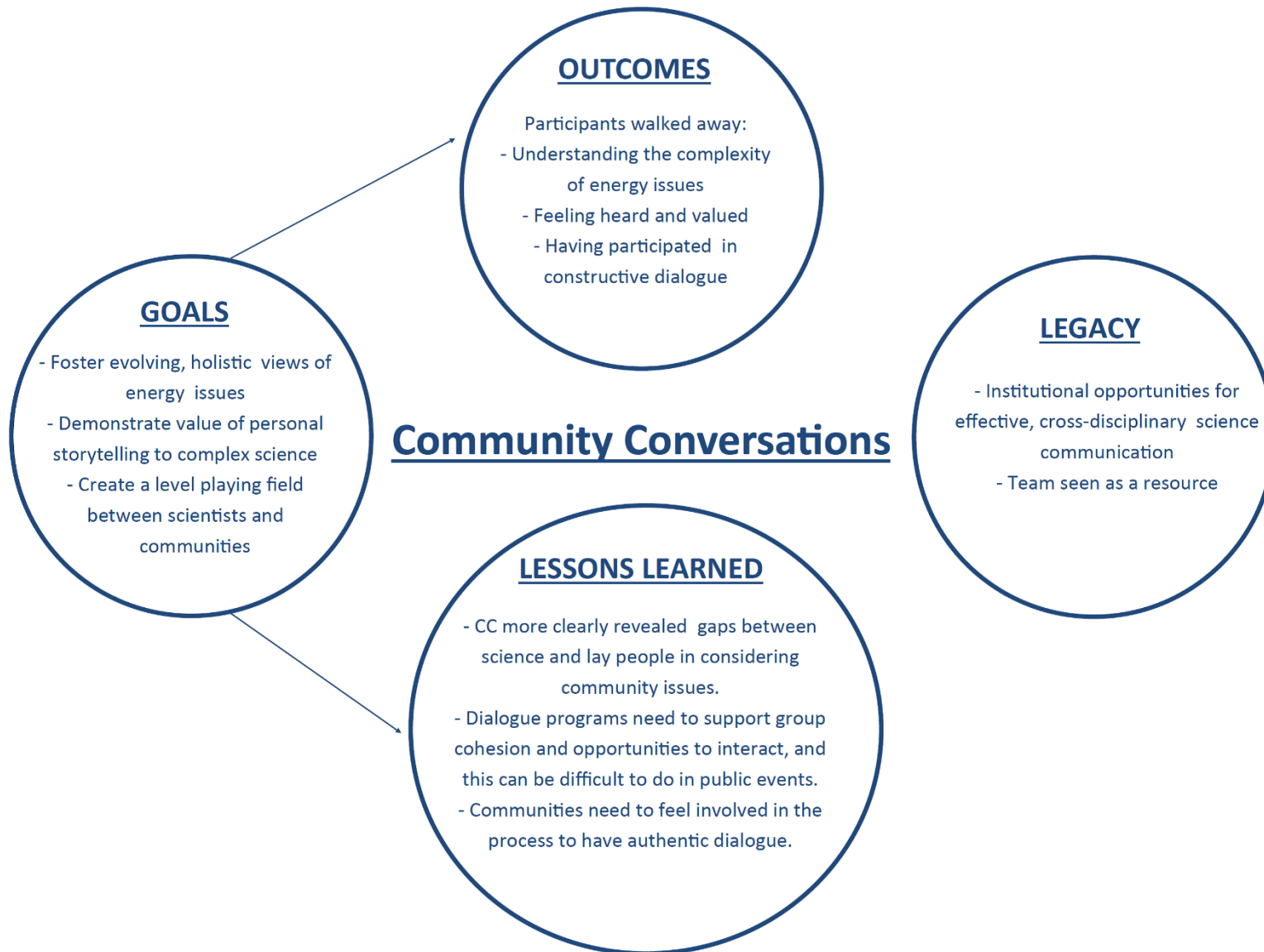
- Database of orphan and abandoned wells
- Engaging the Department of Energy with citizen science groups

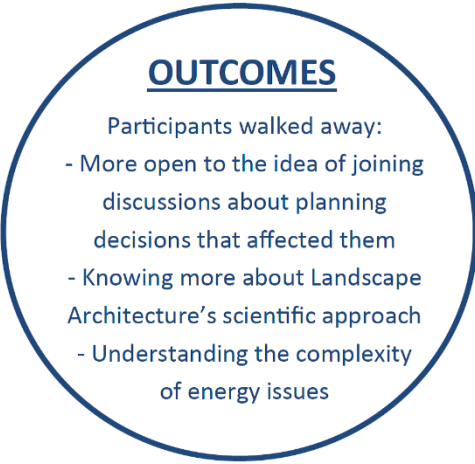
Overall Project

- 21 academic conference presentations
- 6 academic papers
- 10 presentations to local community groups, environmental groups, local and state government, foresters, and other stakeholders

Appendix B: Team Reflections on Programs







MarcellusByDesign



