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Training Early Career Great Lakes Scientists for Effective Engagement and Impact

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Abstract: Freshwater systems worldwide are increasingly facing complex environmental issues. In the Laurentian Great Lakes region, harmful algal blooms are one example spanning agriculture, municipal drinking water, science and monitoring, water quality, and human health. Addressing these challenges and working across stakeholder interests requires sound science and additional skills that are not necessarily taught to graduate students in the apprentice research model. Effective stakeholder engagement and science communication are two areas consistent with emphases on broader impacts from the National Science Foundation, information and dissemination of the National Institutes of Health, and community engagement of the National Institutes of Health's Institute of Environmental Health Sciences. The lack of training in these areas creates a gap for outreach, engagement, and science communication training to help enable researchers to translate important science to influential stakeholders, policy makers, and members of the public. To address this gap, we held a Community-Engaged Scholarship Workshop for graduate students and early career faculty. The workshop used an established community-engagement framework and was tailored to address the complex environmental issue of harmful algal blooms. It addressed four community-engagement competencies, including community-engaged partnerships, community-engaged teaching and learning, community-engaged research, and science communications. Here, we report evaluation results on changes in these four competencies and participant satisfaction. We conclude with a discussion of potential improvements and next steps for those seeking to host similar community-engaged trainings.

Keywords: *harmful algal blooms, professional development, science communication, science to policy, complex environmental problems*

Since the early 2000s, there have been calls for Great Lakes scientists to bridge science and policy communities as communication between scientists and policy makers can be an effective way to address any disconnect, especially for complex environmental problems (Rittell and Webber 1973; Innvaer et al. 2002; Krantzberg 2004; Dreelin and Rose 2008). In Michigan, nearly half of a statewide water policy fellows group, composed of representatives from academia, local governments, state agencies, environmental groups, industry, agriculture, and business, identified that not enough science is currently being used in water policy decisions (Dreelin and Rose 2008). Regionally, community engagement within policy implementation arenas is identified as critical to achieving a prosperous Great Lakes-St. Lawrence River basin (Krantzberg et al. 2015).

Graduate students play an important role in cutting edge research; however, the graduate education in science, technology, engineering, and math (STEM) fields generally follows an apprenticeship model where graduate students learn from an established researcher (Vergara et al. 2014). Even though students are prepared to conduct independent research, the challenge is in developing skills and facilitating experiences that will help graduate students see how their research addresses

complex environmental problems, while working across multiple disciplines and with stakeholders, especially if they pursue a nonacademic career (Muir and Schwartz 2009; Vergara et al. 2014; Matthews et al. 2015). To complement student learning in their disciplinary training and graduate research, professional development programs can be effective at helping students develop other useful skills and learn new perspectives (Leshner 2007; Matthews et al. 2015). In the context of complex environmental problems, community-engagement and science communications training are necessary to narrow the skills gap for scientists, so that they may collaborate across a variety of disciplines, government agencies, community partners, and sector stakeholders effectively (Latimore et al. 2014). The Great Lakes Center for Fresh Waters and Human Health recently hosted a community-engaged scholarship professional development workshop, primarily geared toward graduate students and post-doctoral students associated with the Center.

In this manuscript, we (1) describe the professional development workshop, (2) present evaluation results, and (3) discuss implications of this type of program for preparing scientists to work in partnership on complex environmental problems affecting the Great Lakes. The conceptual model for the workshop, impacts, and discussion of implications of this program may provide valuable information for similar institutions working in other regions in order to build the capacity necessary for effective community engagement and science communication.

Program Description

To facilitate in-depth learning, the Community-Engaged Scholarship Workshop was held on four consecutive days from May 20-23, 2019 at the Maumee Bay Lodge and Conference Center in Oregon, OH, USA. This workshop model is considered to be a mid-level training program because there are more contact hours than a single workshop, but fewer than a year-long fellows program (Prevost et al. 2017). Participants were recruited from the recently established Great Lakes Center for Fresh Waters and Human Health (hereafter Great Lakes Center) faculty, staff, students, and partners via email invitation and meeting announcements. Great Lakes Center leaders were encouraged to share the training program opportunity with their labs and networks. This training is a key component of the community-engagement core of the Great Lakes Center, created in 2018 and led by faculty from Bowling Green State University (BGSU). The Great Lakes Center is a collaborative effort with nine other universities and research institutions and is one of four centers funded through the National Science Foundation (NSF) and the National Institute of Environmental Health Sciences (NIEHS) – a unit within the National Institutes of Health. Additional recruitment occurred at the other NSF/NIEHS-funded centers, the Great Lakes Sea Grant Programs, Michigan State University (MSU) Extension/Michigan Sea Grant Extension fellows, MSU Environmental Science and Policy Program, and other professional networks within the Great Lakes region.

Michigan State University is a national leader with its Graduate Certification in Community Engagement that has evolved since its inception in 2008. The certification consists of 20 competency areas aligned to the following eight dimensions (Doberneck et al. 2017, 128):

1. foundations in community-engaged scholarship;
2. community partnerships;
3. criticality in community engagement;
4. community-engaged scholarship and practice;
5. approaches and perspectives;
6. evaluation and assessment;
7. communication and scholarly skills; and
8. successful community-engagement careers.

The program reported herein was based on the community-engagement competency framework described above, and was refined through an informal needs assessment to better meet the learning interests of the participants with focused interests on fresh water, Great Lakes, and water quality, including challenges caused by harmful algal blooms (HABs). The workshop content utilized a variety of teaching methods, including traditional lecture-style presentations, case studies that highlighted community-based HABs response, expert panel discussions, "speed networking"

round-tables featuring community-engagement programs, and a field trip where participants were able to get a first-hand look at water treatment plant infrastructure and HABs response protocols. The overall workshop sessions, descriptions, format, and contacts are listed in Table 1.

A planning committee consisted of representatives from the Michigan Department of Natural Resources, MSU Extension, Michigan Sea Grant, Michigan Department of Agriculture and Rural Development, Ohio State University Stone Lab and Ohio Sea Grant, the Great Lakes Center, BGSU, University of Windsor, and community partners. The committee completed the pre-workshop informal needs assessment, and through it, reduced the above eight competency areas to four and increased the emphasis on science communication, consistent with the competencies of community-engagement and Extension professionals (Blickley et al. 2013; Suvedi and Kaplowitz 2016; Atiles 2019). Our learning goals were to:

1. Increase knowledge of approaches to community-engaged partnerships;
2. Increase knowledge of community-engaged teaching and learning;
3. Increase knowledge of community-engaged research; and
4. Increase knowledge of science communications tools, resources, and perspectives of professionals in the field.

Methods

The purpose of this evaluation was to determine efficacy of this mid-level professional development workshop at achieving the above stated learning goals. An evaluation survey included retrospective pretest-posttest questions (Nimon et al. 2011) related to community-engagement competencies, Likert-type questions focused on the workshop's organization, and open-ended qualitative questions. Participants were asked to rank their self-assessed proficiency in 19 competency areas on a 4-point Likert scale from none to proficient, where none = 0, basic = 1, intermediate = 2, and proficient = 3. These competency areas addressed participant knowledge in partnership principles, community-engagement tactics, and science communication strategies. In addition, the Community-Engaged Scholarship Workshop sought to evaluate participants' perception of the water treatment industry's response to HABs. This was addressed in part through a field trip where participants heard from the Administrator of the Toledo Water Treatment Plant and given a tour of a low pumping station, part of the City of Toledo water treatment infrastructure. This tour allowed participants to see the facilities and hear directly from staff who were involved in the City of Toledo's microcystin water contamination event in 2014 and response afterwards.

In order to assess program structure and organization, workshop participants were asked to rank statements pertaining to individual sessions as well as the workshop as a whole. Program statements were ranked from strongly disagree to strongly agree, with strongly disagree = 1 and strongly agree = 4. Eight statements were about program sessions; examples include: sessions built together well as a whole, the learning activities helped reinforce the main points of the sessions, and there was enough time for questions and answers during sessions. Additionally, participants were asked to rank statements pertaining to how they felt about the workshop overall from strongly disagree to strongly agree, with strongly disagree = 1 and strongly agree = 4. Ten program statements were utilized to gauge participants' perceptions on how the workshop content helped them to better understand stakeholder perspectives, how well it provided beneficial resources and tools, and whether attending this workshop strengthened their professional network or career.

Workshop participants were also asked what, if any, resources from this program they planned to take back and share in their workplaces. This question reflects the value of the resources provided by the program speakers and how participants saw resources fitting into their work. Resources presented during the workshop were designed to introduce participants to a range of tools, networks, and techniques that may assist in sharing their work and/or engaging their community partners. These resources were also designed to provide inspiration and novel brainstorming for participants' current research as well as for future projects. Resources included target audience and stakeholder

Table 1. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019.

	Session	Description - Objectives
	Session 1: Workshop welcome and introduction	Discussion of goals, workshop overview
Principles of partnerships	Session 2: Stakeholder identification and engagement	Lecture: Who are our stakeholders and why should we engage them? Speaker: Diane Doberneck, Michigan State University Outreach and Engagement
	Session 3: Collaborative partnerships with landowners	Lecture: Collaborative partnerships with landowners. Speaker: Ricardo Costa-Silva, Michigan State University Extension
	Session 4: Principles of community partnerships	Lecture: Principles of community partnerships – reciprocity, benefits, challenges. Speaker: Diane Doberneck, Michigan State University Outreach and Engagement
	Session 5: Collaboration with landowners/farmers	Case study: Science to Solutions program discussion. Speaker: Kate Sanders, Indiana State Department of Agriculture
Communication and public health	Session 6: Community engagement for public health	Panel: Public health and engaging the public on health topics. Speakers: Rebecca Fugitt, Ohio Department of Health and Kelly Frey, Ottawa County Sanitation
	Session 7: Toledo Water Treatment tour	Field trip: Tour of Toledo Water Treatment low service pumping station, discussion of water treatment HABs response. Speaker: Jeff Calmes, City of Toledo
Community-engaged teaching and learning	Session 8: Partnerships for community-engaged teaching/learning	Speed networking: Partnerships for community-engaged teaching & learning/public education. Speakers: Devin Gill (Cooperative Institute for Great Lakes Research, University of Michigan), Michelle Neudeck (Bowling Green State University), Rebecca Wicker (The Nature Conservancy)
	Session 9: Community-engaged research/science	Speed networking: Introduction to community-engaged research/science. Speakers: John Bratton (LimnoTech, LLC, HABs Grab), Jennifer Maucher (NOAA Phytoplankton Monitoring Network), Paul Riser (Erie Hack), Kristin TePas (Illinois-Indiana Sea Grant and EPA *Lake Guardian* shipboard science workshops)
Community-engaged research	Session 10: Citizen science partnerships	Case study: Charter Boat Captains Citizen Science program. Speaker: Justin Chaffin, Ohio Sea Grant, Ohio State University
	Session 11: Multi-stakeholder coalitions for transnational community-engaged research	Case study: University of Michigan Detroit River phosphorus study. Speaker: Lynn Vaccaro, University of Michigan Center for Water Science
Science communication	Session 12: Developing a science communication plan	Practice: Developing a science communications plan & *Message Box* (Compass 2020) activity. Speaker: Rhett Register, Michigan Sea Grant
	Session 13: Communicating with policy makers	Case study: Ohio Sea Grant/Stone Laboratory field trip for policy makers, Stone Lab. Speaker: Justin Chaffin, Ohio Sea Grant, Ohio State University
	Session 14: Communicating with journalists	Panel: Communicating with journalists. Speakers: John Hartig (University of Windsor – Great Lakes Institute for Environmental Research), Tom Henry (*The Blade* newspaper), Georgeann Herbert (Detroit Public Television), Todd Marsee (Michigan Sea Grant), and David Ruck (Great Lakes Outreach Media)
	Session 15: Social media and video strategies	Practice: Social media and video strategies. Speaker: David Ruck, Great Lakes Outreach Media

identification strategies, communication strategies for different audiences, digital engagement tools and techniques (e.g., social media, videography, photography), and community-engagement opportunities (i.e., programs and networks with which to become involved or to share with partners and stakeholders). Additionally, a series of open-ended evaluation questions assessed what program aspects participants found the most impactful, both positively and negatively, and guided recommendations for program revisions.

Survey questions relied on participant self-reports to assess changes in knowledge of the community-engagement topics covered, the perceived value of the training to their careers, and their satisfaction with the training overall. A complete copy of the survey questions can be found in Appendix A. MSU Institutional Review Board approved this study STUDY00000920. The survey was distributed at the conclusion of the workshop in May 2019.

Results

Socio-demographics

Twenty-one participants attended. Of these, 20 provided feedback through the evaluation distributed at the workshop, for a 95% evaluation return rate. Of the 20 completed evaluations, there were 11 females, 8 males, and 1 transgender individual; 8 participants were Master's students, 8 participants were Doctoral students, and 4 identified as Other (respondents included 2 Post-Doctoral researchers, 1 educator, and 1 outreach professional). There was no significant racial diversity. The participant group was largely White (15 responses), though it included 3 Asians and 1 White/Hispanic individual. One survey was returned without a response to this question.

The majority of the respondents were 20-29 years of age (12 responses). The remaining respondents in descending order were: 40-49 years (4 responses), 30-39 years (3 responses), and 50-59 years (1 response). If participants were graduate students or fellows, they were also asked to indicate how likely they were to pursue careers from a list of eight options provided, ranking each option from extremely unlikely to extremely likely, where extremely unlikely = 1 and extremely likely = 5. Eighteen out of twenty surveys returned responded to this question. Nine responses indicated that the participant was extremely likely to pursue a career in research (M = 4.28, SD = 0.87), the highest response mean of careers provided. The remaining career fields were: a university Extension program; outreach; communication; education; policy; management; and engagement. Participants were also given the option to provide their own response, of which four did so, describing fields including: mathematics, laboratory technician, consultant, and one individual considering all given options. Participant responses to their likelihood to pursue fields outside of research were distributed on the Likert scale between neutral and likely (mean range was 2.89 to 3.50).

Community-Engagement Competencies

Prior to participating in the workshop, the self-assessed proficiency mean across all 19 topic areas was 1.26, representing a basic level of proficiency for the group as a whole (Table 2). At the completion of the workshop, the overall mean increased to 2.11, indicating an intermediate level of proficiency. Therefore, the content of this event increased participants' self-assessed competency overall and by one rating level on average.

Table 2. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019, evaluation of overall proficiency (n=19).

	Number of Items	Mean[a]	Standard Deviation	df	*p*
Before participation	19	1.26	0.29	18	0.000
After participation	19	2.11	0.22	18	0.000

[a]Mean responses on a 4-point scale with "none" coded as a 0 and "proficient" coded as a 3.

The self-assessed knowledge of the Community-Engaged Scholarship Workshop participants significantly increased across all program areas (Table 3). Notably, "Water treatment plant response to HABs" was the topic with the highest variability in knowledge (M = 1.05, SD = 1.10, v = 1.21) prior to the workshop, with the mean score commensurate with a basic level of knowledge. Individual responses showed that 40% of respondents (8 responses) had no knowledge of water treatment plant's response to HABs, 30% had basic knowledge (6 responses), 15% had intermediate knowledge (3 responses), and 15% considered themselves proficient (3 responses). At the conclusion of the workshop, the participants' self-assessed knowledge increased overall to an intermediate level of knowledge (M = 2.15, SD = 0.67, v = 0.45). Zero respondents indicated they had no knowledge of the topic following the completion of the workshop, 15% indicated basic knowledge (3 responses), 55% indicated intermediate knowledge (11 responses), and 30% indicated they were proficient (6 responses). "Engaging vulnerable populations for public health" was the topic with the lowest overall knowledge base before the workshop (M = 0.60, SD = 0.60, v = 0.36) (Table 3). Prior to completing the workshop, 45% of respondents had no knowledge of this area (9 responses), 50% had basic knowledge (10 responses), 5% had intermediate knowledge (1 response), and none responded as being proficient. Following the workshop these numbers reversed, with none responding as not having any knowledge, 45% having basic knowledge, 40% having intermediate knowledge, and 15% stating they were proficient.

The participants' pre-workshop level of knowledge was variable, with as much as one level of competency difference between the highest and lowest topic knowledge. "Engaging vulnerable populations for public health" was ranked the lowest with a mean of 0.60. "General principles of partnerships" was ranked highest with a mean of 1.70. This relative difference in the highest and lowest ranked topic knowledge category was similar post-workshop, though the highest ranked topic changed. "Engaging vulnerable populations for public health" remained the lowest competency topic area, though with an increased mean of 1.70 (SD = 0.73), while "translating science for public audiences" became the highest ranked topic area with a mean of 2.50 (SD = 0.61).

Following participation in and completion of the workshop, one participant indicated they had no knowledge in a single workshop topic called the "Spectrum of Participation" – a figure that compares promise to the public, public participation goal, along the axis of inform, consult, involve, collaborate, and empower categories along an axis of increasing impact of the decision (IAP2 2020).

Program Organization

Workshop participants' responses to rank questions pertaining to individual sessions as well as the workshop as a whole provided data from which to assess program structure and organization. None of the evaluation respondents stated they strongly disagreed with any of the statements provided. Eight disagree responses were stated in the evaluation; these were distributed among the following statements: the individual sessions built on each other without being repetitive (1 response); the sessions fit together well as a whole (1 response); the main points of sessions were clearly presented and easily understood (1 response); the handouts/materials provided clear explanations of the ideas (1 response); the case studies provided good examples of engagement work in the Great Lakes region (1 response); there was enough time for questions and answers during the sessions (1 response); and there was enough time throughout the Institute for me to think about how to implement new ideas in my work (2 responses). The majority of respondents selected agree or strongly agree across all program statements (Figure 1).

Participants also provided responses to rank statements pertaining to how they felt about the workshop overall, from strongly disagree to strongly agree. Overall, participants agreed or strongly agreed with all provided statements (Figure 2). There was one disagree response in six of ten program statements including: this Institute provided useful tools for me to intentionally include a wider range of partners in my community-engaged work (1 response); this Institute helped me to better understand the public health dimensions of HABs (1 response); this Institute provided me with strategies to use in my community-engaged

Table 3. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019, respondents' (n = 20) self-ratings of pre-program and post-program community-engagement topic competencies.

Community-engagement Topic Area	Pre-workshop		Post-workshop				
	Mean[a]	SD	Mean[a]	SD	Diff.	Z	*p* [b]
Partnerships							
Community outreach and engagement approaches	1.40	0.75	2.25	0.55	0.85	-3.900	0.000
Stakeholder and community partner identification	1.35	0.93	2.30	0.66	0.95	-3.578	0.000
Spectrum of participation	1.26	0.93	2.10	0.85	0.84	-3.557	0.000
Multi-institutional coalition building	1.15	0.75	1.80	0.62	0.65	-3.357	0.001
General principles of partnerships	1.70	0.80	2.21	0.71	0.51	-3.051	0.002
Engaging vulnerable populations for public health	0.60	0.60	1.70	0.73	1.10	-3.640	0.000
Water treatment plant responses to HABs	1.05	1.10	2.15	0.67	1.10	-3.470	0.001
Community-engaged teaching and learning							
Partnerships for advancing teaching and learning	1.25	0.72	1.95	0.61	0.70	-3.500	0.000
Multiple practices for engaged teaching and learning	1.45	0.76	2.10	0.64	0.65	-2.968	0.003
Community-engaged research							
Partnerships for advancing science and research	1.55	0.76	2.30	0.57	0.75	-3.638	0.000
Multiple practices for engaged science and research	1.45	0.83	2.30	0.66	0.85	-3.494	0.000
Science communication							
Developing a science communication plan	1.20	0.77	2.15	0.67	0.95	-3.819	0.000
Identifying multiple public audiences for your work	1.65	0.88	2.35	0.59	0.70	-3.500	0.000
Translating science for specific public audiences	1.60	0.88	2.50	0.61	0.90	-3.626	0.000
Multiple practices for engaging with policy makers	0.95	0.83	1.75	0.72	0.80	-3.771	0.000
Multiple practices for engaging with journalists	0.80	0.89	1.85	0.75	1.05	-3.666	0.000
Social media strategies for science communication	1.20	0.77	2.05	0.69	0.85	-3.494	0.000
Capacity to engage stakeholders and partners in the sustainability of the Great Lakes region	1.10	0.79	2.05	0.69	0.95	-3.578	0.000
Strategies for strengthening communication, outreach, and engagement activities related to your own work	1.20	0.70	2.15	0.59	0.95	-3.578	0.000

[a]Mean responses on a 4-point scale with "strongly disagree" coded as a 0 and "strongly agree" coded as a 3.
[b]Statistical significance between post- and pre-program determined using Wilcoxon signed rank tests ($p \leq 0.05$).

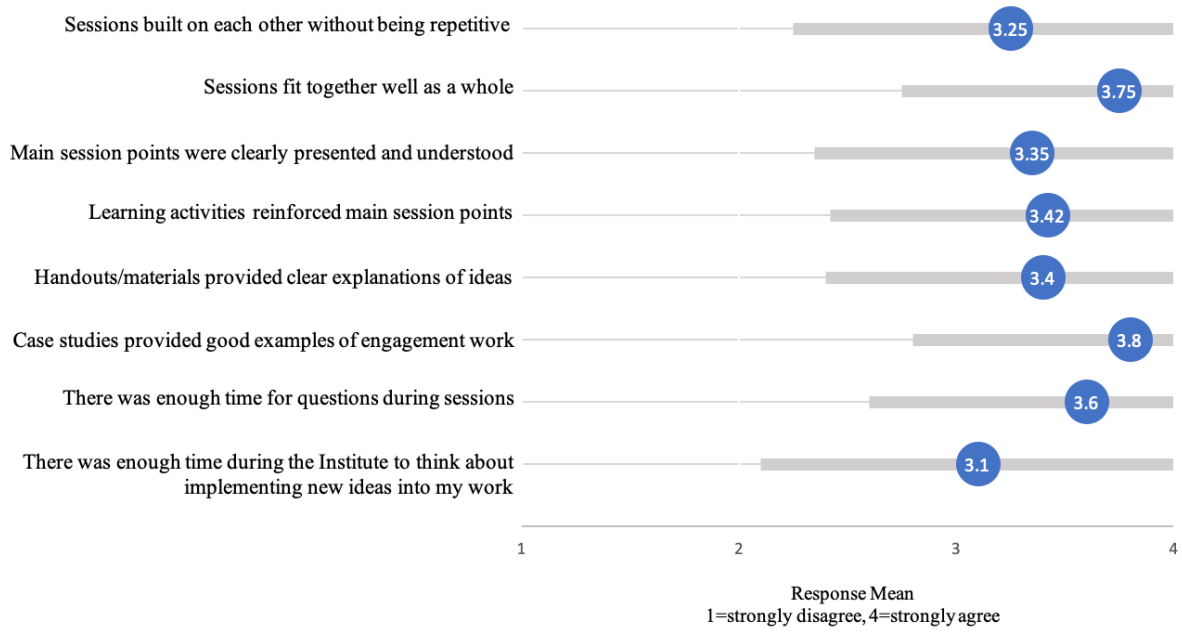

Figure 1. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019, participants' (n=20) agreement or disagreement with session statements.

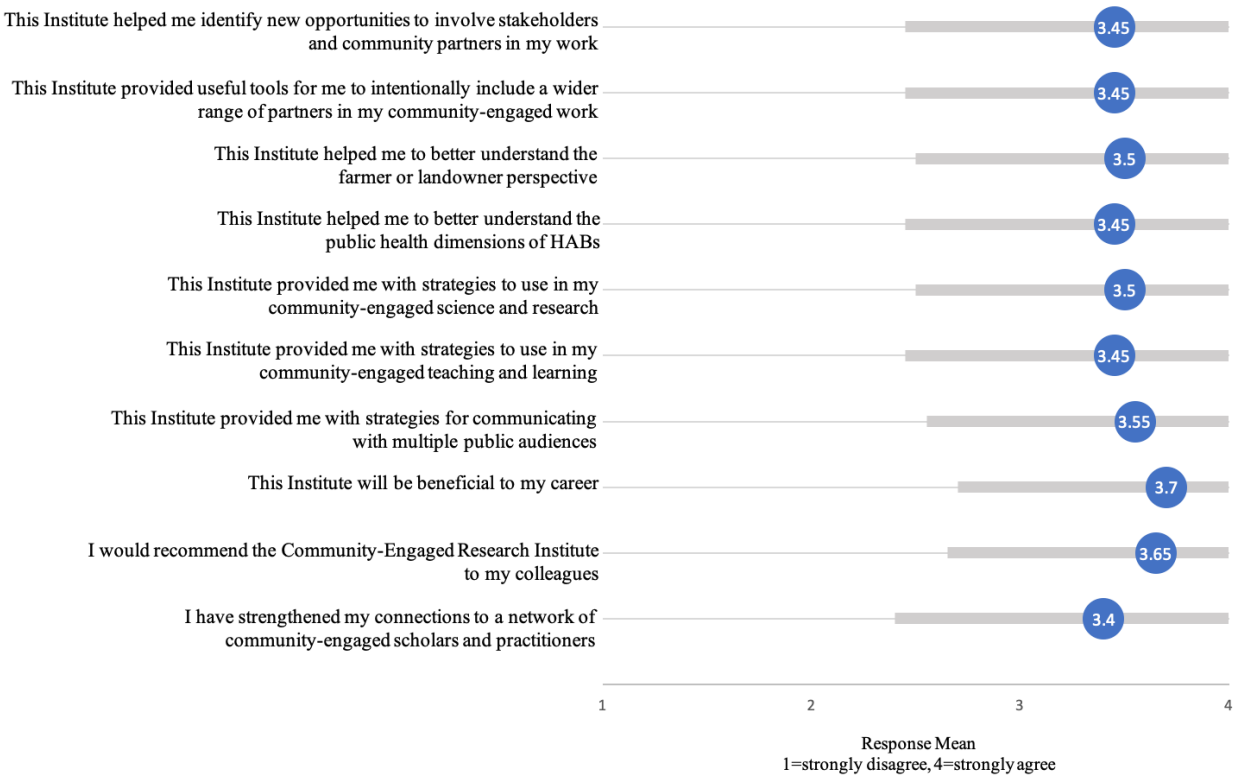

Figure 2. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019, participants' (n=20) agreement or disagreement with overall program statements.

teaching and learning (1 response); this Institute will be beneficial to my career (1 response); I would recommend the Community-Engaged Research Institute to my colleagues (1 response); and I have strengthened my connections to a network of community-engaged scholars and practitioners (1 response).

The evaluation survey also addressed workshop areas that could be added or expanded as well as those that participants were dissatisfied with and could be re-evaluated in future program planning (Table 4). Responses to open-ended questions were summarized for interpretation of program impact. There were 18 responses to workshop areas that could be added or expanded and 15 responses to workshop areas that needed improvement or adjustment. Four responses to the question "What session topics should we consider dropping?" stated that they had no recommendations and were not listed in Table 4. Overall, participants had more positive written comments regarding session topics and case studies than negative comments and had few recommendations on how to improve the workshop. Those recommendations that were listed included revising session duration, more inclusion of real world application of presented concepts, more focus to the speed networking round-table discussions, and increased variety of teaching methods (less lecture). Responses from open-ended questions also informed as to which parts of the program participants enjoyed the most or least. Again, there were more positive responses than negative (Table 5), and many responses for least favorite aspects were suggestions of improvements for future workshops rather than statements of dissatisfaction. In all questions regarding workshop content preferences, participant opinion was variable, with some of the same topics listed as both an area to expand upon as well as one to consider dropping.

Lastly, the evaluation asked participants which of the provided workshop resources they planned to take back to share with their workplace, research team, or home campus. Seventeen participants provided responses to this question. The open-ended format allowed participants to list multiple resources in the same response. The program elements participants planned to take back and share in their workspaces were:

- Community partnerships and stakeholder engagement strategies – including identifying partners outside of academia in order to broaden community discussion and impact of projects/programs (9 responses);
- Science communication's *Message Box* (Compass 2020) activity (7 responses);
- Science communication strategies (3 responses);
- Video/social media strategies (3 responses);
- Citizen science programs (3 responses); and
- Networking/contact information (1 response).

In addition, two responses indicated that they found all program information and resources useful and planned to share them with their workspaces. Two responses mentioned the skills and information learned during the workshop in general terms, stating that they would use it in their future work.

Discussion

The Community-Engaged Scholarship Workshop achieved its overall learning goals. These included assisting graduate students and early career scientists in gaining a better understanding of community partnerships, especially related to the public health aspects of HABs and related challenges facing water treatment facilities, and in gaining science communication skills broadly defined. This works toward building capacity for scientists to communicate with policy makers thereby decreasing the current gap in science-informed water policy decisions (Krantzberg 2004; Dreelin and Rose 2008). These community-engagement and science communication skills can enable scientists to engage with the public and teach about their science effectively and to address the need for well-educated, engaged, and influential stakeholder communities on Great Lakes topics (Krantzberg et al. 2015). Such science-to-society translational skills will become increasingly important as complex environmental problems, such as toxin-producing HABs, become more prevalent and severe (Creed and Laurent 2015). Without broader impacts training (Heath et al. 2014), Sandford (2015, 195) warns that "ineffective engagement is the kiss of death" during a time when a coherently coordinated Great Lakes basin governance is needed even more now than in the past.

Table 4. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019, respondents' session preferences.

Topics to Expand or Add (n=18)	**Topics to Adjust or Eliminate** (n=15)
Content • Speed networking • Partnerships (both with specific stakeholders like policy makers/public health officials as well as in general) • Increased practice time – science communication's *Message Box* activity (Compass 2020) • Increased time with journalist panel • Specific examples of successful/unsuccessful community engagement (more "how to" and lessons learned) • Link research and community-engagement outreach – translating abstracts into science stories, applying *Message Box* (Compass 2020) into research • Public health and engaging the public (more applied level) Organization • Goal setting to be more developed at beginning of training • Opportunity for participant networking	Content • *Message Box* (Compass 2020) activity – needed clarification • Ohio Sea Grant/Stone Laboratory field trip for policy makers • Shorten sessions – "Collaborative partnerships with landowners" & "Who are stakeholders and why should we engage them?" Organization • More focus/variety to speed networking • More case study/real world application, fewer lectures

Table 5. Great Lakes Center for Fresh Waters and Human Health, Community-Engaged Scholarship Workshop, Ohio, 2019, participants' (n=20) most and least favorite program aspects.

Most Favorite	**Least Favorite**
Content • Field trip • Speed networking • Panel discussions • Science communication's *Message Box* (Compass 2020) activity • Networking opportunities • Science to Solutions presentation • Case study examples Organization • All-inclusive, wide range of topics covered • Appreciation for schedule and time management	Content • Introduction to/synthesis of speed networking • Communicating with policy makers Organization • Balance of activities vs. lecture • Breaks too short • Desire more networking opportunities with speakers/participants (possible social hour following sessions?) • Too little time outside • Not enough session clarity – need to outline key skills per session; what are participants supposed to learn?

The Community-Engaged Scholarship Workshop self-assessed evaluation showed a substantial improvement of knowledge of presented topics, particularly those focused on communication, vulnerable populations and HABs, water treatment facility response to HABs, and engaging audiences. The high means of program competencies post-workshop demonstrate that the program was effective in conveying this information, particularly in community-engagement areas in which participants were not previously familiar. No competency area mean increased by less than 0.5 and 6 of 19 (32%) increased by less than 0.8, which indicates a moderate self-assessed knowledge gain by participants based on the Likert scale provided, ranking self-assessed competency from zero to four, where zero indicated no proficiency and four indicated high proficiency. The areas of moderate knowledge gain were those regarding creating partnerships and advancing scientific research. This result may be due to the audience's research background and affiliation with the Great Lakes Center. However, since both overall competency and individual competency area means increased post-workshop, this would indicate that workshop content proved useful to participants in improving their self-assessed knowledge. Due to the fact that there was only one individual who indicated they had gained no knowledge post-workshop, this is likely a reflection of one individual's feelings on the program, rather than the knowledge gained by the participants as a group, which is consistent with the fact that all other program topics eliminated the "no knowledge" responses post-workshop. This supports the assessment of workshop informational content being beneficial to reducing the knowledge gap of participants.

The workshop was rated highly by participants for program satisfaction, indicating participants agreed that session structure, session content, and workshop organization were carried out effectively. Specifically noted was the use of case studies featuring community-engagement work in the Great Lakes region. We believe this method of teaching enabled participants to gain enhanced knowledge of engagement work as well as identified points of contact related to those projects, which may be useful in pursuing similar projects themselves in the future. The workshop was also rated as being successful at helping participants with strategies for communicating with multiple public audiences.

Respondents strongly agreed that the professional development will be beneficial to their careers and professional networks and would recommend it to their colleagues. The number of survey responses indicating a career path in research may be reflective of the audience's affiliation with the Great Lakes Center rather than any impact of the workshop content. This choice may be indicative of other factors such as personal interest of study, preferred career pathway or goals, or a participant's area of expertise.

Given the preliminary evaluation of this workshop, other academic institutions, departments, or organizations may be interested in drawing upon this model and tailoring it to meet their desired learner needs in order to achieve the necessary skills in effective engagement and science communication. One way may be through graduate student professional development, such as the Michigan Sea Grant/MSU Extension Graduate Fellows Program (Triezenberg et al. 2020) that was modeled after MSU Graduate School's Future Academic Scholars in Teaching Fellowship Program (Prevost et al. 2017). Another option may be to offer or require courses on outreach, engagement, and science communication in graduate degree programs (Heath et al. 2014; Latimore et al. 2014). This is increasingly important as federal granting agencies in the United States often require proposals be reviewed according to the science and the broader impacts (Heath et al. 2014). These are built upon the assumption that the science is better as a result of ongoing feedback between the researchers and the public (Heath et al. 2014) and the community use of information developed in these approaches is enhanced (Doberneck et al. 2017).

If academic units adopt professional development programs or offer coursework in outreach and engagement, we recommend utilizing the eight community-engagement competency areas for graduate and professional students or Extension professionals (Suvedi and Kaplowitz 2016; Doberneck et al. 2017; Atiles 2019). As with any initiative, tailoring program goals to their specific audience or desired topics (e.g.,

HABs, microplastics, invasive species) based on a community needs assessment and input from an advisory council responsible for oversight of workshop goals and objectives is necessary. Similar future workshops at other institutions may also consider improving teaching and learning strategies for how to effectively address the importance of strong community partnerships. If an institution's workshop audience is more diverse than that which was presented in this study, these concepts may be even more necessary in order to address background knowledge gaps in these areas.

Based on the results of the Community-Engaged Scholarship Workshop evaluations, considerations for future workshops would include the incorporation of experiential learning such as field trips and the inclusion of community partners and practitioners as guest speakers. We also recommend the involvement of state and local officials, public health officials, researchers, journalists, other media leaders, and non-governmental leaders, in order to strive for diversity in perspectives and backgrounds that would facilitate community discussion and understanding. Further research is also needed in order to identify additional existing relevant case studies or to develop new relevant case studies for inclusion into future workshops. The addition of active learning activities such as lightning talks, interactive polls, mind-mapping, reflection worksheets, social learning discussions, practice, etc., can help participants bridge theory and practice and develop their own community-engaged scholarship approaches. Active learning is an effective technique helping learners to advance understanding and application in STEM concepts (Freeman et al. 2014). Evaluation is necessary to assess outcomes, make workshop improvements, and inform future professional development practice. This community-engaged approach could prepare scientists to work together and with communities to address the grand challenges of the Laurentian Great Lakes region.

While we had limited racial and ethnic diversity among our survey respondents of program participants, we had greater variation in gender identity with approximately half identifying as female. The lack of racial and ethnic diversity may be mostly attributed to the population of graduate students and early career professionals affiliated with the Great Lakes Center and other NSF-NIEHS funded centers. However, women, Black, Indigenous, and people of color are more likely to be community-engaged scholars (Post et al. 2016; Flaherty 2017). Therefore, to some extent, our training reached White male participants who are traditionally underrepresented in community-engaged scholarship trainings, even though these demographics are contrary to diversification goals of STEM fields.

Future research could explore the longer-term impact of the concepts learned in the workshop because nearly half of the respondents indicated that they would utilize the concepts of community partnerships and stakeholder engagement strategies in their work. Additionally, if we combine general science communication with the *Message Box* activity (Compass 2020), nearly half of respondents indicated they would bring these topics and activities back to their program.

Conclusion

Graduate school is a time of socialization for future careers that includes internalizing norms and expectations of given society (Austin et al. 2009). Employing best practices for community-engaged scholarship, bridging the science to policy gap, and communicating with public audiences (Krantzberg 2004; Dreelin and Rose 2008) requires commitment of experienced scientists, as well as commitment of graduate students and early career scientists toward improving Great Lakes governance needs (Sandford 2015).

Scientists will be able to more effectively work together and partner with agencies, communities, and other stakeholders in addressing complex environmental issues if they have a solid foundation in community-engaged scholarship and science communication. Here, we presented the program model and evaluation results for a Community-Engaged Scholarship Workshop for graduate students and early career scientists within the context of the Great Lakes Center. Overall, we achieved learning goals of increased knowledge of community-engaged partnerships, community-engaged teaching and learning, community-engaged research, and science communication. Our program was based on the literature on professional

development for community engagement and then refined through the informal needs assessment. The result was four main areas to concentrate on conceptually: partnerships, teaching/learning, research, and science communications. These points of emphases are consistent with scholarship on graduate student professional development for broader impacts and conservation careers.

This community-engagement workshop model can be used by academic programs to build capacity in order to achieve broader societal impacts, and to inform and disseminate critical information to stakeholders – outcomes desired by funding agencies such as the NSF, the National Institutes of Health, and the National Institute of Environmental Health. Effective utilization of community-engaged scholarship approaches can result in better science due to the feedback from communities (Heath et al. 2014). At the same time, communities are more likely to utilize the information needed because they were involved in the process and it yields results important for them to consider.

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Appendix A

Great Lakes and Human Health Community-Engaged Research Institute Scholarship, May 20-23, 2019, Evaluation Survey.

1. BEFORE you participated in this program, what was your level of competency in each of the following areas? (None, Basic, Intermediate, or Proficient?)
    a. Stakeholder and community partner identification
    b. Spectrum of participation
    c. Multi-institutional coalition building
    d. General principles of partnerships
    e. Engaging vulnerable populations for public health
    f. Water treatment plant response to HABs
    g. Partnerships for advancing teaching and learning
    h. Multiple practices for engaged science and research
    i. Developing a science communication plan
    j. Identifying multiple public audiences for your work
    k. Translating science for specific public audiences
    l. Multiple practices for engaging with policy makers
    m. Multiple practices for engaging with journalists
    n. Social media strategies for science communication
    o. Capacity to engage stakeholders and partners in the sustainability of the Great Lakes region
    p. Strategies for strengthening communication, outreach, and engagement activities related to your own work
2. NOW what is your level of competency in each of the following areas? (statements provided were the same as question 1)
3. Please indicate how much you agree or disagree with each of the following statements about the sessions:
    a. The individual sessions build on each other without being repetitive.
    b. The sessions fit together well as a whole.
    c. The main points of sessions were clearly presented and easily understood.
    d. The learning activities helped reinforce the main points of the sessions.
    e. The handouts/materials provided clear explanations of the ideas.
    f. The case studies provided good examples of engagement work in the Great Lakes region.
    g. There was enough time for questions and answers during the sessions.
    h. There was enough time throughout the Institute for me to think about how to implement new ideas in my work.
4. What session topics should we consider expanding or adding?
5. What session topics should we consider dropping?
6. Please indicate how much you agree or disagree with the following about the program overall:
    a. This Institute helped me identify new opportunities to involve stakeholders and community partners in my work.
    b. This Institute provided useful tools for me to intentionally include a wider range of partners in my community-engaged work.
    c. This Institute helped me to better understand the farmer or landowner perspective.
    d. This Institute helped me to better understand the public health dimensions of HABs.
    e. This Institute provided me with strategies to use in my community-engaged science and research.
    f. This Institute provided me with strategies to use in my community-engaged teaching and learning.
    g. This Institute provided me with strategies for communicating with multiple public audiences.
    h. This Institute will be beneficial to my career.

i. I would recommend the Community-Engaged Research Institute to my colleagues.

j. I have strengthened my connections to a network of community-engaged scholars and practitioners.

7. What was the best part of the program?
8. What aspects of the program could be improved?
9. Are there resources you plan to take back and share with your research team, lab, or home campus? If so, what do you plan to share?
10. Any additional comments about the program?
11. I am a: (please select one)
    a. Master's student
    b. Doctoral student
    c. Other (please specify)
12. I identify myself as: (please select one)
    a. Female
    b. Male
    c. Transgender
    d. Other
13. What is your race? (please select one)
    a. American Indian or Alaska Native
    b. Asian
    c. Black or African American
    d. Native Hawaiian and other Pacific Islander
    e. White
    f. Other, please specify:
14. What is your ethnicity? (please select one)
    a. Hispanic, Latino or Spanish origin
    b. Not of Hispanic, Latino or Spanish origin
    c. Other, please specify:
15. I am in this age range: (please select one)
    a. 20-29 years
    b. 30-39 years
    c. 40-49 years
    d. 50-59 years
    e. 60 years and above
16. If you are a graduate student or fellow, how likely is it that you will pursue a career in… (please select one per row)
    a. Extension
    b. Outreach
    c. Communication
    d. Education
    e. Policy
    f. Management
    g. Engagement
    h. Research
    i. Other, please describe:

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