

Expanding the CyberAmbassadors Program to Include Mentoring for Emerging CI Careers

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ABSTRACT

Advanced computing infrastructure has fostered tremendous growth and innovation across research and practice in STEM (science, technology, engineering, math). Cyberinfrastructure (CI) professionals often collaborate with disciplinary experts who want to leverage computation; in order to contribute effectively to this work CI professionals need both technical and professional skills. There are many formal and informal opportunities for the CI workforce to gain technical skills, and the CyberAmbassadors program (NSF Award #1730137) developed new curriculum to provide CI professionals with opportunities to build their professional skills. More than 19,000 participant trainings have been completed, including almost 900 individuals who have earned a certificate for completing the entire CyberAmbassadors program.

This paper describes initial efforts to expand CyberAmbassadors to include training on culturally-aware mentoring skills, with a focus on fostering professional success in the CI workforce – which is still an evolving profession with no single entry path. The new mentoring curriculum will help CI professionals at all levels develop the self-assessment, planning, and networking skills necessary to build strong mentoring relationships that can help them navigate emerging CI career paths. The mentoring curriculum will build on the communications, teamwork and leadership skills training from the existing CyberAmbassadors program, and will offer specialized practice in key career development activities like offering constructive feedback, fostering a growth mindset, developing a mentoring network, and building transferable skills. The new curriculum will also integrate research about the benefits of culturally-aware mentoring, which seeks to provide broad support for mentees with diverse identities and experiences. Once finalized, the new curriculum will be distributed broadly through a national network of volunteer facilitators who provide trainings for their own campuses, companies and communities.

KEYWORDS

Mentoring, Professional Skills, CI Workforce Development

1 INTRODUCTION

As the career pathways for the cyberinfrastructure (CI) workforce continue to evolve, it has become apparent that CI professionals

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need a variety of disciplinary, technical, and professional skills to support interdisciplinary collaborations. The CyberAmbassadors program developed curriculum to offer training in communications, teamwork and leadership skills in the context of interdisciplinary work in STEM. More than 19,000 participant trainings had been completed by the end of the 2024-25 academic year, including almost 900 individuals who earned a certificate for completing the entire training program. About 150 volunteer facilitators have been trained to use the CyberAmbassadors curriculum to offer communications, teamwork, and leadership skills trainings for their own campuses, companies, and communities.

The CyberAmbassadors project also identified additional needs for professional development – in particular, a need for new training in culturally-aware mentoring of the CI workforce, with a focus on supporting career development in emerging fields. This type of mentoring is distinct from the apprenticeship-style mentoring commonly used in academic and research settings, which is a successful approach for faculty who are preparing graduate students and postdocs for academic careers. The emerging nature of the CI workforce requires a different approach to mentoring and career development in order to support the unique challenges of excelling in roles that are constantly evolving and preparing for jobs that may not exist yet. This paper describes pilot efforts to expand the CyberAmbassadors curriculum to prepare culturally-aware, career-focused mentors to support the CI workforce.

2 BACKGROUND AND RELATED WORK

The CyberAmbassadors program was originally designed to serve CI professionals and the STEM (science, technology, engineering, math) students, postdoctoral trainees, and research scientists who collaborate with and may ultimately join the CI workforce. The remainder of this section highlights a few of the existing technical training programs and supportive resources for the CI workforce and summarizes results from the CyberAmbassadors program.

2.1 Technical Training Efforts

A number of excellent resources for technical training have emerged to serve the CI community, many through NSF workforce development efforts. Indeed, since 2017 the NSF has funded almost 150 grants with the word “CyberTraining” in the title [50]; a cursory review indicates most focus on technical skills such as parallel programming, quantum computing, Data Science, or learning AI. Many of these efforts are reflected in the ACCESS program [2], which coordinates national efforts to make CI hardware and software more accessible to the research community – along with training and resources ranging from workshops to efforts to match researchers with experts who can help. Other federally-funded efforts to support the CI workforce include the Advanced Cyberinfrastructure

Research and Education Facilitators “Virtual Residency,” which is an important annual resource for students and practitioners interested in growing their CI careers [51]. The Carpentries [18] offer technical training in data science, computer programming, and library science to support both domain experts and computational specialists.

2.2 Professional Development Programs

Beyond technical training, there are many professional development opportunities and organizations to support the CI workforce. For example, in addition to technical skills the “Virtual Residency” also provides professional skills training, including activities from the CyberAmbassador curriculum. The Campus Champions offer a national network of support for research computing facilitators, including a curated repository of resources and training materials [11, 61]. The Campus Research Computing Consortium (CaRCC) [22] hosts forums where individuals can ask questions and seek support for their technical and professional needs, as well as a variety of interest groups like the RCD Nexus (Research Computing and Data Resource and Career Center) [23]. There are also many professional organizations that support more specialized communities, like the Research Data Access and Preservation Association [57] that serves research librarians, archivists, and data scientists.

2.3 Results of CyberAmbassadors Pilot

The CyberAmbassadors pilot project (NSF Award #1730137) resulted in more than 24 hours of training activities to help build professional skills among the CI workforce [14, 43]. Materials are freely distributed as open educational resources, with a Creative Commons license. A non-credit certificate program was added in 2021 to recognize participants who completed 9+ hours of training across the curriculum, which currently includes nine sessions organized into three themes.

Communications sessions cover interpersonal communication skills for solving complex problems:

- First Contact: Communicating with Purpose
- Let’s Talk: Communicating about Problems
- It’s Complicated: Communicating about Complexity

Teamwork sessions discuss skills for working more effectively in interdisciplinary teams:

- Teaming Up: Effective Group and Meeting Management
- Speaking Up: Effective Presentation Skills
- Leveling Up: Problem Solving and Decision Making

Leadership sessions explore best practices for ethical, inclusive leadership within the CI workforce:

- Leading the Team: Understanding Style and Personality
- Leading the Change: Equity and Inclusion
- Leading with Principles: Ethics

Dozens of universities, professional associations, and research facilities have hosted CyberAmbassadors trainings; and the curriculum has also been used as part of outreach activities like the Mississippi Coding Academy. Tau Beta Pi, the Engineering Honor Society, adopted the CyberAmbassadors materials as the core curriculum of its Engineering Futures professional development program and has committed to hosting the open-source curriculum in the long term,

Table 1: Summary of Pilot CyberAmbassadors Outcomes

Acad. Year	Total Sessions	Total Participants (In-Person Remote)	Certificates Earned
2017-18	3	344 (88 256)	n/a
2018-19	34	1,456(713 743)	n/a
2019-20	36	824 (547 277)	n/a
2020-21	45	1,919 (58 1,861)	72
2021-22	83	2,150 (720 1,430)	147
2022-23	167	4,217 (1,990 2,227)	188
2023-24	151	3,947 (1,920 2,027)	191
2024-25	168	4,427 (1,909 2,518)	285
Totals	687	19,284 (7,945 11,339)	883

ensuring that it will continue to be freely available to interested trainers and participants.

A key part of the success of the CyberAmbassadors project is the “train the trainers” effort to prepare volunteers to use the curriculum to offer professional skills training for their own campuses and communities [13]. As of summer 2025, nearly 150 facilitators have been trained to use the CyberAmbassadors curriculum materials, allowing the program to reach a global audience. Due to the pandemic, the curriculum was adapted for synchronous, interactive, online delivery and that has remained a popular modality in addition to in-person trainings. Table 1 summarizes the outcomes for the original pilot project (a 3-year grant extended to six years due to the pandemic), and demonstrates the program’s sustained success since the end of the funding period.

3 MENTORING FOR CI CAREERS

The rapid evolution of cyberinfrastructure means that effectively mentoring the CI workforce requires a focus on lifelong learning and preparing for emerging careers [7, 15, 16, 25, 27, 59]. In order to help mentees build successful careers in CI, mentors need to understand how to support mentees in building transferable skills for jobs that may not exist yet. As the CI workforce expands, it is also important to strengthen mentors’ skills for supporting mentees across disciplines, experiences, and cultures. The remainder of this section describes some existing approaches to training mentors, including several CI workforce development projects, and discusses initial efforts to expand the CyberAmbassadors program to offer more focused training for mentoring the CI workforce.

3.1 Existing Approaches to Mentor Training

Formal and informal mentoring relationships have a variety of benefits, which vary depending on the participants and context. For example, the apprentice model of mentoring is well-studied in research contexts where faculty mentors prepare graduate students and postdocs for academic careers [32, 44, 54–56]. In other contexts, mentors may focus on career exploration by helping undergraduates [9, 10] and graduate/postdoctoral students [26, 38] understand career options and gain confidence in their job search. Mentoring can also help individuals identify and develop “transferable skills” like the ability to solve problems, work in diverse teams, and organize complex projects [35, 47, 63]. All of these approaches to

mentoring require foundational professional skills like communicating effectively, discussing expectations, setting goals, identifying areas for technical and non-technical growth, and planning for personal and professional development.

The communication, teamwork, and leadership skills covered in the existing CyberAmbassadors program are valuable for building mentor-mentee relationships. Many federally-funded CI workforce development projects include efforts to match and support mentor-mentee pairs, often in the context of building technical and problem-solving skills. Several of these programs have adopted the CyberAmbassadors training as part of the professional development for their participants (CIREN, NSF Award #2230106; SCIP: CI PIVOT, NSF Award #2321091; CCMNet NSF Award #2216311). This CyberAmbassadors training can provide mentors with a strong foundation in essential professional skills, but the existing curriculum does not offer specific training to help mentors support the unique career development needs of the CI workforce.

3.2 CyberAmbassadors Mentor Training

Early efforts are underway to expand the CyberAmbassadors program to help train mentors (and mentees) in the CI workforce. The new mentoring curriculum builds on the existing training in communication, teamwork and leadership, as these skills are foundational to strong mentor-mentee relationships. The new curriculum is also informed by ongoing research on the benefits of helping mentors and mentees build skills for understanding and integrating their cultural backgrounds and personal experiences in professional contexts [8, 68]. Culturally-aware mentoring approaches value the unique experiences and backgrounds of both the mentor and mentee, and work to acknowledge and integrate their personal and professional trajectories as part of the mentoring relationship. Mentors who take the time to learn about their mentees' backgrounds and adapt their mentoring approaches accordingly can develop stronger, more effective relationships that help foster mentees' career success [5, 33, 37].

The new CyberAmbassadors mentoring curriculum leverages lessons learned from the work of CIMER [28], which provides extensive training and support for culturally-aware mentoring in research contexts (e.g., faculty mentoring graduate students and postdocs). The new curriculum also draws on expertise from the Michigan State University Graduate Career Development Office [29], which specializes in helping graduate/postdoctoral trainees navigate diverse professional contexts and build the transferable skills necessary for success in emerging careers.

Just as with the original CyberAmbassadors training, constructivist and sociocultural pedagogical approaches are being used to develop the new mentoring curriculum. Constructivism and socioculturalism are based in Vygotsky's theory of social constructivism [65, 67], which views context as a critical element of the learning process. Constructivism describes learning as an active process of sense-making [36, 42, 52] while socioculturalism emphasizes the role of context and the importance of integrating new information with familiar experiences and ideas [24, 40, 41]. Rooted in these approaches, the CyberAmbassadors training strives to include examples and activities from a variety of contexts (e.g., working in an interdisciplinary team, completing a data analysis task, attending a

conference or professional meeting). The goal is to build on familiar contexts in order to make it easier for participants to connect the new skills and information they are learning with their past experiences and knowledge.

Just as the original CyberAmbassadors curriculum has a modular format with multiple examples and activities for different audiences, the new mentoring training will be easily customizable for participants with varied career experiences and goals. Table 2 summarizes the types of learning objectives and activities that are likely to become part of the mentoring curriculum; the final materials will be developed based in part on participant feedback.

4 INITIAL MENTORING PILOT

In July 2025, an initial pilot training was developed to explore mentoring in the context of CI careers. 15 participants were recruited from Michigan State University employees, with most coming from the Information Technology and Research Infrastructure communities on campus. Four competency areas were selected as the focus of this initial mentor training: aligning expectations, fostering independence, communicating about problems, and providing feedback. The 3-hour training was conducted in-person in a conference room on campus. At the end of the training, participants were asked to complete a program evaluation form that collected basic demographics; asked about satisfaction with the overall training and the relevance of the content to participants' typical work responsibilities; and offered an opportunity to self-evaluate their confidence or ability to meet the learning goals of the training. 11 participants completed the evaluation form, and the remainder of this section summarizes their feedback on the pilot training.

4.1 Participant Demographics

Of the 11 respondents, 3 had completed an undergraduate degree, 3 had earned a Master's degree, and the remaining 5 had PhDs. 6 participants reported that their primary field of study or area of expertise was in information technology, research computing, or software development; the remaining 5 participants came from a variety of academic backgrounds: computational astrophysics, plant biology, chemistry and materials science, geography (remote sensing), and student affairs administration. 5 individuals reported that they were relatively early in their current careers (1-5 years of experience), while 3 were mid-career (10-15 years of experience) and 3 were advanced in their careers (20+ years of experience). When asked why they decided to participate in the training, all of the participants indicated that they hoped to develop skills and improve their mentoring abilities.

4.2 Overall Workshop Evaluation

Participants were asked to rate their satisfaction with the structure of the overall workshop using a Likert scale of 1=not at all satisfied; 2=slightly satisfied; 3=moderately satisfied; 4=very satisfied; and 5=extremely satisfied. Table 3 summarizes these data.

Participants were also asked to report their satisfaction with specific topics or activities, and to indicate how relevant each was to their typical daily work. Responses were recorded using a Likert scale of 1=not at all satisfied or relevant through 5=extremely satisfied or relevant: Table 4 summarizes this feedback.

Table 2: Example Learning Objectives and Learning Activities for New Mentoring Curriculum

<p>Participants will be able to define mentoring relationships and describe how the relationship between mentors/mentees changes over time</p> <ul style="list-style-type: none"> • Introduction to mentoring relationships • Discussion of mentor/mentee roles • Brainstorming relationship-impacting events <p>Participants will be able to assess their technical and professional skills and areas for growth</p> <ul style="list-style-type: none"> • Discuss assessment and training resources • Brainstorm skill-building opportunities <p>Participants will be able to develop goals for professional growth and a plan for achieving them</p> <ul style="list-style-type: none"> • Explore Individual Development Plans • Practice goal-setting conversations <p>Participants will be able to identify and leverage opportunities to grow their professional networks</p> <ul style="list-style-type: none"> • Introduce the use of multiple mentors • Explore the role of professional organizations <p>Participants will be able to initiate a conversation about balancing personal and professional goals</p> <ul style="list-style-type: none"> • Practice identifying and clarifying values/goals • Role play mentor-mentee conversations <p>Participants will be able to acknowledge and discuss the impact of culture and experience</p> <ul style="list-style-type: none"> • Explore differences in culture and experience • Practice engaging in respectful conversations <p>Participants will be able to give and receive constructive feedback</p> <ul style="list-style-type: none"> • Exploring self-reflection activities • Role play mentor-mentee conversations
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4.3 Aligning Expectations

The aligning expectations segment of the training started by exploring definitions of mentoring in the context of career development. These included mentoring as a “collaborative effort to meet each others’ changing needs, and prepare mentees for success in their chosen career” [45] and mentoring as offering “career guidance, skill development, and psychosocial support that increase mentees’ self-efficacy, persistence, and career satisfaction” [55]. Participants were introduced to recent research that indicates effective mentoring can prepare mentees for career success [49, 60, 64], enhance mentees’ self-efficacy [3, 12, 17, 39], and improve mentees’ career satisfaction and retention [6, 58, 66]. The discussion covered characteristics of successful and failed mentoring relationships [61] and an exploration of the various roles and responsibilities mentors may assume (mentoring, supervising, advising, and/or sponsoring) [46]. Participants also discussed ways to help mentees gain experience and prepare for future career opportunities, and what types of “resume building” opportunities might be helpful for mentees. The training also provided practical tips for developing strong letters of recommendation for mentees, and discussed the types of written agreements and documentation that can help mentors and mentees discuss and align expectations.

Participants were asked to complete a self-evaluation of their confidence or ability before and after the training for each of the learning goals. Table 5 summarizes the average responses for the

Table 3: Average Satisfaction with Workshop Structure

Evaluation Area	Satisfaction
Structure	4.4
Pacing	4.0
Appropriate content for my level of expertise	4.5
Variety of activities	4.1
Opportunities to practice or apply new skills/info	4.0
Facilitators’ ability to engage participants	4.8
Facilitators’ ability to answer questions	4.9

learning goals in the aligning expectations portion of the training. Participants used a Likert scale where 1=very low; 2=below average; 3=average; 4=above average; 5=very high.

4.4 Fostering Independence

In the fostering independence section, participants were introduced to the idea of developing a series of scaffolded projects to help new mentees build skills [21]. The first project is an introductory task that is designed to help the mentee acclimate to their new role and give them an early “win” to build confidence. Good tasks for this type of introductory project are things like downloading and installing key software or tools; reviewing orientation materials and completing onboarding tasks; or setting up the computers, accounts, and communication channels (slack, git, etc.) that they will need to work effectively with their new colleagues. As a rule of thumb, a task that would take the mentor 20-60 minutes to complete is often a good candidate for these introductory tasks – but the mentee should be given a full week to complete the task. That leaves time for overcoming unexpected challenges (e.g., needing to wait for access rights or hardware connections) if needed, and allows mentees to exceed expectations early on if they are able to complete the task sooner.

In addition to the introductory task, mentors were encouraged to assign a second-level task that would take them 1-2 hours. The mentee is given two weeks to complete this secondary task, which could be assigned at the same time as the introductory task if appropriate. Often these are “administrative” tasks like re-running an existing experiment or workflow to check reproducibility (and to learn how things are done in their new workplace); reviewing the unit’s website or other documentation and identifying a handful of bugs, typos, or updates that are needed; or completing data entry tasks. The goal for this secondary or administrative task is for the mentee to tackle a more open-ended project that encourages them to explore existing resources and find answers more independently.

Once mentees have successfully completed these first two tasks, mentors are encouraged to assign an independent project that might take them 2-4 weeks to complete – but which the mentee has months to complete. Ideally, these independent projects will result in output that the mentee can share with others and potentially receive external feedback (e.g., a presentation, poster, or publication). This not only helps the mentee to build their resume, but also gives them the opportunity to work more independently and take more ownership of a longer-term project. This type of project is often a “filler” that mentees can work on in between other assigned tasks, which helps ensure that there is always something productive to

Table 4: Average Satisfaction with and Relevance of Specific Training Topics or Activities

Topic or Activity	Satisfaction	Relevance
Workshop Introduction	4.5	4.0
Overview of Mentoring	4.5	4.4
Resumes and Recommendations	4.2	3.8
Exploring Expectations Documents	4.6	4.6
Scaffolded Structuring of Projects	4.6	4.3
Paired Peer Mentoring	4.2	3.8
Defining Problem Types	4.5	4.7
Report Inconsistencies Case Study	3.6	3.7
Impact of Communication Styles	4.4	4.5
Best Practices for Giving Feedback	4.3	4.8

Table 5: Average Before and After Self-Evaluation Responses for Aligning Expectations Learning Goals

Learning Goal	Before	After	Diff
Define effective mentoring and explain why it is important	3.1	4.6	1.5
Identify characteristics of successful mentoring relationships	3.5	4.6	1.1
Work collaboratively with mentees to identify goals and action plans	3.3	4.6	1.3
Describe methods for documenting mentoring plans	2.5	4.4	1.9

make progress on even when the mentor may not be able to provide immediate feedback or new assignments.

In addition to strategies for assigning scaffolded tasks that allow mentees to build skills, participants were introduced to the use of peer mentors and partnered work assignments as another way to help mentees gain confidence and independence [4, 10, 20, 30, 39]. There are a number of approaches that can be successful depending on the circumstances, including matching mentees with similar backgrounds or pairing more senior mentees with less experienced ones. In all cases, having the peer mentors meet regularly (typically on a weekly basis) is important: they should be prepared to discuss current successes and challenges with their peer mentor, and to provide feedback on what their partner shares. The goal is for the peer mentors to become the “first resource” for each other: asking questions, brainstorming ideas, troubleshooting solutions, and determining together whether and when it is appropriate to bring an issue to the mentor. This approach helps mentees build their teamwork and communication skills while developing confidence in working with less direct supervision from their mentor.

Table 6 summarizes participants’ self-evaluations of their confidence and ability to achieve the learning goals for the fostering independence segment of the training. In this Likert scale 1=very low; 2=below average; 3=average; 4=above average; 5=very high.

4.5 Communicating about Problems

This section of the mentor training draws directly from the existing CyberAmbassadors program, specifically the module called “Let’s Talk: Communicating about Problems.” The longer-term goal is for the mentoring curriculum to become part of the CyberAmbassadors

certificate program, but for this pilot training it was important for participants to have an introduction to some of the communication skills necessary for strong mentoring relationships. This segment begins with a discussion about different types of problems (ability, motivational, interpersonal) and approaches for resolving them in ways that both solve the problem and maintain the relationship [19]. Participants were also introduced to strategies for responding to strong emotions in the workplace [53] and discussed the role of conversational style [62] in communicating effectively within mentoring relationships.

Table 7 shares participants’ self-evaluations of their confidence and ability to achieve the learning goals for the communicating about problems segment of the training. In this Likert scale 1=very low; 2=below average; 3=average; 4=above average; 5=very high.

4.6 Providing Feedback

The final segment of the pilot training focused on providing feedback to mentees. Participants reviewed best practices for why, when, and how to provide effective feedback [1, 31, 34, 48]. Discussion topics included how to balance positive and negative feedback; the value of providing feedback early and often; and the importance of giving specific feedback that can help mentees understand what led to success or what needs improvement. Specific approaches for providing written and oral feedback were reviewed, like asking mentees to include brief descriptions of key tasks as part of their timesheets or to prepare and present a slide summarizing their accomplishments and challenges as part of regular group meetings.

Table 8 includes participants’ self-evaluations of their confidence and ability to achieve the learning goals for the providing feedback segment of the training. In this Likert scale 1=very low; 2=below average; 3=average; 4=above average; 5=very high.

5 DISCUSSION AND FUTURE WORK

While this initial pilot training was small (15 participants, 11 of whom completed the evaluation), it did confirm some areas of strength and highlight some interesting areas for future work. The facilitators who developed and conducted this pilot training also developed the original CyberAmbassadors curriculum, so it is not surprising that there was high overall satisfaction with the structure, content, and pacing of the training – and with the facilitators’ skills at engaging participants and answering questions.

Satisfaction with the specific topics and activities was also high overall, with one outlier in the “Report Inconsistencies” case study. This activity asked participants to discuss in small groups the following scenario: “Your student has a report due in two days, right before the start of winter break. Everyone is anxious to take a break and your student has been working overtime to compile the information. But when you reviewed the draft this morning, you realized there are significant inconsistencies.” This activity was part of the Communicating about Problems segment, and participants were asked to consider what might be the source of the problem and how they might resolve it. Satisfaction is generally high for this activity when it is presented as part of the Communications training within the original CyberAmbassadors program, but pulling out a subsection of that training for this pilot proved to be less effective. Based on participant comments, it seems that the challenges

Table 6: Average Before and After Self-Evaluation Responses for Fostering Independence Learning Goals

Learning Goal	Before	After	Diff
Describe the value of scaffolded projects in fostering mentees' independence	3.0	4.5	1.5
Describe the value of peer mentoring and paired learning experiences for fostering mentees' independence	3.1	4.5	1.4

Table 7: Average Before and After Self-Evaluation Responses for Communicating about Problems Learning Goals

Learning Goal	Before	After	Diff
Define effective problem solving and effective communication	3.4	4.4	1.0
Identify the characteristics of three common types of problems	2.7	4.6	1.9
Practice different processes for diagnosing and solving problems	2.9	4.4	1.5
Describe the impact of communication style and list factors that can influence individual styles	3.0	4.4	1.4

Table 8: Average Before and After Self-Evaluation Responses for Providing Feedback Learning Goals

Learning Goal	Before	After	Diff
Identify best practices for giving feedback to mentees, including why, when, and how to provide effective feedback	3.1	4.3	1.2
Describe the relative benefits of different oral and written communication methods for giving feedback to mentees	3.1	4.2	1.1
Discuss the value of failure as a learning experience, and identify opportunities for constructive failure	3.3	4.1	0.8

stemmed from limited discussion time and a level of discomfort with the ambiguity of the scenario – meaning that participants were not sure they found the “right” answers. In the longer term, the plan is to offer the Communications and Mentoring trainings separately as part of a larger workshop series, which will likely resolve these concerns as there is more time for discussion during a Communications-focused training.

In looking at participants' evaluation of the relevance of different elements of the training to their typical work, three items were rated as only of average relevance: resumes and recommendations; paired peer mentoring; and the case study. These responses are interesting in that all three items focused more on an “academic” context. All of our participants were employed by Michigan State University and most of them supervised student interns or employees. Knowing this, the facilitators designed these activities to reflect experiences with students on a college campus. However, about half of the participants worked in information technology (a support unit, rather than an academic one) and many had experience in industry. One open-ended evaluation response noted that recommendation letters may be less common in industry, and discussion during

the training suggested a broader range of working environments that may impact the relevance of peer mentoring approaches (e.g., having only one mentee, or being a mentor but not the supervisor and thus lacking authority to assign partners). As these training materials are refined, attention will need to be paid to the balance of academic and industry contexts and approaches.

In the aligning expectations segment, participants reported gains in their confidence or ability to meet all of the learning goals. During the training, the most robust discussion centered on the four roles or responsibilities of mentors that were introduced, based on [46]:

- **Mentoring:** a focus on nurturing growth, with the goal of understanding mentees' goals and interests and encouraging their progress
- **Supervising:** acting as “the boss” and telling mentees what they need to do, how to do it, and when it is due
- **Advising:** sharing your expertise and telling mentees what you think they should do, based on your experiences
- **Sponsoring:** advocating for your mentee, creating opportunities, and helping them make connections

The overall sense of participants' conversation was that this framework was helpful for thinking about their varied experiences with mentees. Several questions were raised about authority and how to navigate mentoring relationships when you are not a supervisor or employer, and additional time, examples, and activities may need to be allocated to this topic in future trainings.

Participants' evaluation of the fostering independence segment of the training was interesting, as there was a notable increase in confidence for both learning goals (scaffolded projects and peer mentoring). However, these were also topics that many participants found less relevant to their daily work. Given the small sample, it is not clear what adjustments may be beneficial in this portion of the training so additional data will need to be gathered.

The materials presented in the communicating about problems section of the training were the best-developed, since they were pulled from existing CyberAmbassadors training. Participants reported gains in their confidence and/or ability in all four of the learning goals, but the facilitators' assessment after the training was that this segment did not flow well with the other materials. In the original CyberAmbassadors program, there is a logical progression of skills as participants move from the Communications training into Teamwork and then Leadership. While it is not required that trainings be completed in that order, it is encouraged where possible since many participants find the flow between modules to be helpful. The new mentoring curriculum is envisioned as a fourth module, ideally to be completed after the Leadership training. In that scenario, participants would already have completed the training on communicating about problems before taking the mentoring workshops. For this pilot training, most participants had little experience with the CyberAmbassadors program so the decision was made to incorporate elements of the communications training. In the longer term, however, the goal is to offer these separately.

The final segment of the pilot training focused on providing feedback, and while participants reported gains in their ability and confidence with the learning goals overall these were lower than the other segments. It seems likely that part of this was due to a lack of time during the training, as discussions during earlier segments

lasted longer than anticipated so the feedback section was a bit rushed. More data will need to be collected from additional pilots in order to better determine what adjustments might be needed for the feedback portion of the mentor training.

Moving forward, the facilitators plan to continue developing and testing the mentoring curriculum materials with varied audiences, likely including graduate students, industry professionals, and participants in disciplinary conferences. The training will also be adapted for delivery in online, synchronous, discussion-based formats. The final materials will be provided to the network of volunteer facilitators who currently offer CyberAmbassadors training, which should allow the new mentoring curriculum to reach a broad national and international audience.

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