

CyberAmbassadors: Results from Pilot Testing a New Professional Skills Curriculum

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ABSTRACT

The CyberAmbassadors Project (NSF #1730137) is a training grant to develop professional skills curriculum (communications, teamwork, leadership) to build capacity in Cyber Infrastructure (CI) Professionals. CI Professionals are experts at high performance computing, data science algorithms, and/or supercomputing infrastructure; they are often called upon to work with experts from STEM (science, technology, engineering, mathematics) in multi-disciplinary teams to solve complex problems. The CyberAmbassadors training program seeks to improve the function of these teams by helping CI Professionals build and practice skills for effective communication, teamwork and leadership within the context of complex, multidisciplinary research. This paper summarizes the results of the pilot testing of the CyberAmbassadors curriculum, which was conducted at institutions across the United States using both in-person, online and hybrid delivery methods. A Kirkpatrick evaluation model was used to assess expectations and reasons for participation, as well as satisfaction with the training and impacts on participants' learning and behavior. The curriculum was revised based on these initial pilot tests, and 43 volunteers have participated in "train the trainers" workshops to prepare to facilitate this training on a larger scale during 2019-20.

CCS CONCEPTS

• **Social and professional topics** → Professional topics; Computing profession; Computing occupations.

KEYWORDS

CI workforce development, professional skills training, pilot study

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1 INTRODUCTION

The National Science Foundation (NSF) has called for increased workforce training in support of advanced CyberInfrastructure (CI) [1]. In this context, CI Professionals are described as experts in using CI infrastructure such as advanced computing hardware (i.e., "supercomputers") and the associated computational software and algorithms used to manipulate "big data" from STEM (science, technology, engineering, math) and other disciplines. The CyberAmbassadors Project (NSF Award #1730137) responds to this call by developing interactive training to help CI Professionals strengthen their professional skills (communications, teamwork, leadership) so that they can contribute more effectively to the complex, collaborative, multidisciplinary research that increasingly relies on CyberInfrastructure [2]. The 3-year CyberAmbassadors Project proposed the following objectives:

- Develop Curriculum that focuses on professional skills (communications, teamwork, leadership) within the context of large scale, multidisciplinary computational research
- Pilot, Evaluate and Revise the curriculum at appropriate universities, conferences, and laboratories; the initial goal was to pilot the materials with a minimum of 75 participants
- "Train the Trainers" by collaborating with external partners (e.g., XSEDE, CIMER, Tau Beta Pi) to prepare a cohort of at least 20 facilitators who can offer the CyberAmbassadors training at their local/regional institutions and events

By the end of the second year of the project, the CyberAmbassadors program had met all of these objectives, training more than 400 participants during the pilot testing phase and providing two "train the trainer" workshops at Michigan State University to train 43 volunteers as facilitators. At least one additional facilitator training is planned (May 2020), and the CyberAmbassadors project team has developed relationships with several organizations that will continue to host the curriculum materials, assist with facilitator training, and collect and disseminate program evaluations after the end of the grant funding. The remainder of this paper describes the CyberAmbassadors curriculum, outcomes from the pilot tests, and results from the initial facilitator training (in July 2019, with 25 participants).

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2 OVERVIEW OF THE CURRICULUM

The CyberAmbassadors training is an opportunity to learn and practice skills for communicating effectively, working in diverse teams, and leading and mentoring interdisciplinary researchers [3]. The training is highly interactive, and rooted in two complementary educational frameworks (constructivism and socioculturism) that emphasize learning as an active process of meaning-making within a shared context [4–9]. Small- and large-group discussions and role-playing activities are central to the CyberAmbassadors training; these approaches have been shown to support active learning [10] in settings that range from healthcare [11–14] and business [15–17] to science and engineering [18, 19]. The CyberAmbassadors curriculum is also grounded in research about effective interpersonal communications [15, 17, 20–23]; teamwork [24–28]. [29]; and leadership [13, 14, 30–38]. The CyberAmbassadors curriculum materials are free and licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License [39]. This license lets others use, remix, tweak, and build upon this work non-commercially, as long as they credit this source and license their new creations under the identical terms.

The curriculum is organized into 9 modules, each with a minimum “run time” of 55-70 minutes. The facilitator’s manual is designed to support users in adapting the materials for different audiences, topics and timelines. Time permitting, each module can easily run 2+ hours, providing more than 18 hours of training divided into three main sections: communications, teamwork and leadership. The remainder of this section describes each module, and Table 1 summarizes key learning goals.

Module 1. Introduction: The CyberAmbassadors Program (55m). The CyberAmbassadors program seeks to help CyberInfrastructure (CI) Professionals strengthen their communication, teamwork and leadership skills in order to more effectively contribute to computationally-intensive, interdisciplinary projects in STEM (science, technology, engineering, mathematics). As a first step, this introductory module focuses on establishing positive group dynamics and laying the ground rules for engaging in this professional skills development program. Establishing these parameters at the beginning of the training experience fosters a supportive, respectful environment and helps ensure participants are able to engage in shared learning.

Module 2. First Contact: Communicating with Purpose (70m). Effective networking can foster learning, invite collaborations, and uncover new opportunities for personal and professional success. The “First Contact” module explores the ways that new people, new tasks, new resources and new contexts can impact interpersonal communications. Participants learn the value of first contact in different settings (networking, elevator pitches, computational consulting) and build specific skills for communicating in unfamiliar situations, with the goal of developing connections, sharing ideas and building partnerships.

Module 3. Let’s Talk: Communicating about Problems (70m). Strong interpersonal communication skills can foster success in both professional and personal situations. The “Let’s Talk” module focuses on building participants’ capacity to engage in meaningful, one-on-one conversations about challenging topics. Participants explore common types of problems and practice skills

for resolving ability, motivation and interpersonal problem situations.

Module 4. It’s Complicated: Communicating about Complexity (65m). CI Professionals often find themselves working on problems that are both technically complex and complicated by differences in collaborators’ expertise, backgrounds, and communication styles. The “It’s Complicated” module focuses on helping participants understand complex conversations and practice skills for communicating more effectively in both the speaker and listener roles.

Module 5. Teaming Up: Effective Groups and Meetings (60m). Assigning individuals to work in a group does not automatically create a well-functioning team. The “Teaming Up” session focuses on understanding the conditions necessary for groups to develop into effective teams and offers participants practical tools for encouraging team growth. This session also explores ways to make meetings more effective, including developing strong agendas and ensuring that three key meeting leadership roles are filled (facilitator, note taker, time keeper).

Module 6. Leveling Up: Problem Solving and Decision Making (70m). Brainstorming is a common activity used both to generate new ideas and as a team-building experience. The “Leveling Up” module focuses on helping CI Professionals become effective facilitators for problem solving and decision making activities. Specific skills for facilitating brainstorming sessions are discussed, along with practical tools for helping groups distill the results of brainstorming into actionable solutions and activities to help spark creativity.

Module 7. Leading the Team: Understanding Style and Personality (70m). CI Professionals are often asked to work collaboratively and to take on leadership roles. When working in teams and leading projects, it is helpful to understand how to leverage one’s natural personality and preferred leadership style most effectively. In “Leading the Team,” participants explore different aspects of leadership; reflect on their own leadership skills, values and goals; and develop a language for understanding and cultivating capable leaders.

Module 8. Leading the Change: Equity and Inclusion (60m). Diversity, in many dimensions, offers both challenges and opportunities to any relationship. Learning to identify, reflect upon, learn from, and engage with diverse perspectives is essential to fostering effective relationships and vibrant intellectual environments.

Module 9. Leading with Principles: Ethics (50m). CI Professionals play an important role in both teaching and modeling ethical behavior. There are ethical issues centering on the underlying cyberinfrastructure: how to set up, maintain and secure resources, and how to use them appropriately to support research and practice. There are also ethical issues surrounding the relationships between CI Professionals and their colleagues, supervisors, and the public. Reflecting upon and discussing ethical behavior is an important part of becoming an effective CI Professional, and is the focus of the “Leading with Principles” module.

3 PILOT TESTING

Three modules within the CyberAmbassadors curriculum (Introduction, Leading the Change, and Leading with Principles) were

Table 1: Learning Goals and Activities for CyberAmbassadors Curriculum

	By the end of the session, participants will be able to. . . .	Key Activities to Achieve Learning Goals
Introduction	Learn about the CyberAmbassadors program history, objectives and structure, and about the facilitator(s) for this training	<ul style="list-style-type: none"> • Welcome • CyberAmbassadorsProgram Overview
	Learn about other participants and begin building a learning community	<ul style="list-style-type: none"> • Introductions
	Reflect on group dynamics and ways to make the group functional	<ul style="list-style-type: none"> • Examining Group Behaviors
	Establish ground rules for participation	<ul style="list-style-type: none"> • Generate Ground Rules
First Contact	Recognize the parameters of “First Contact”	<ul style="list-style-type: none"> • Defining First Contact
	Describe the psychological challenges of networking	<ul style="list-style-type: none"> • First Contact: Networking
	Model effective communication skills for networking	<ul style="list-style-type: none"> • Networking Rehearsal
	Explain the role and value of stories during First Contact	<ul style="list-style-type: none"> • Crafting a Memorable Story
	Recognize stages of team growth and methods to navigate this First Contact	<ul style="list-style-type: none"> • First Contact: Teams
	Model effective communications skills for navigating Consulting First Contact	<ul style="list-style-type: none"> • First Contact: Consulting
Let's Talk	Describe problem and solution states, and list three common types of problems	<ul style="list-style-type: none"> • Defining Effective Problem Solving
	Illustrate the process of diagnosing/solving ability and motivation problems	<ul style="list-style-type: none"> • Solving Ability and Motivation Problems
	Summarize the requirements for effective communication	<ul style="list-style-type: none"> • Mirroring
	Define interpersonal problems and describe approaches for resolving them	<ul style="list-style-type: none"> • Solving Interpersonal Problems
	Model effective communications skills for resolving interpersonal problems	<ul style="list-style-type: none"> • Communicating Problems Rehearsal
It's Complicated	Recognize the conditions for communicating effectively about complexity	<ul style="list-style-type: none"> • Introducing Complex Conversations
	Describe the three tools for speakers during complex conversations	<ul style="list-style-type: none"> • Tools for the Speaker
	Model effective speaking skills during complex conversations	<ul style="list-style-type: none"> • Speaker Rehearsal
	Describe the three tools for listeners during complex conversations	<ul style="list-style-type: none"> • Tools for the Listener
	Model effective listening skills during complex conversations	<ul style="list-style-type: none"> • Listener Rehearsal
Teaming Up	Describe the stages of team formation and related leadership activities	<ul style="list-style-type: none"> • Understanding Team Development
	Develop an effective agenda that reflects the priorities and goals of the meeting	<ul style="list-style-type: none"> • Developing Effective Agendas
	Describe three key roles for managing effective meetings	<ul style="list-style-type: none"> • Meeting Participants and Roles
	List ways meetings might get off track and methods for responding effectively	<ul style="list-style-type: none"> • Managing Distractions in Meetings
	Model effective leadership strategies during a meeting	<ul style="list-style-type: none"> • Meeting Rehearsal
Leveling Up	Explain the value of engaging diverse participants in problem solving	<ul style="list-style-type: none"> • Introducing Brainstorming
	Model the brainstorming process	<ul style="list-style-type: none"> • Brainstorming Exercise
	Identify skills for facilitating effective brainstorming	<ul style="list-style-type: none"> • Facilitation Skills
	Apply facilitation skills to brainstorming and list reduction	<ul style="list-style-type: none"> • Rehearsal Activity
	Illustrate techniques for sparking creativity and helping groups generate ideas	<ul style="list-style-type: none"> • Rut Busters
Leading the Team	Recognize the value of understanding leadership styles and personalities	<ul style="list-style-type: none"> • Introducing Leadership
	Describe key characteristics of three common leadership styles	<ul style="list-style-type: none"> • Leadership Styles
	Conduct a self-assessment of leadership values, goals and progress	<ul style="list-style-type: none"> • Leadership Pizza
	Describe the role of personality in leader effectiveness	<ul style="list-style-type: none"> • Personality Styles
	Model the use of personality assessments for personal development	<ul style="list-style-type: none"> • Personality Inventory
Leading the Change	Recognize the impact of conscious and unconscious assumptions, preconceptions, biases, and prejudices and acquire skills to manage them	<ul style="list-style-type: none"> • Reflecting on Unconscious Assumptions Implications of Diversity Research
	Increase understanding of equity and inclusion and their influence on STEM	<ul style="list-style-type: none"> • Case Study (Language Barriers or Communication Challenges)
	Identify concrete strategies for learning about and addressing issues of equity and inclusion	<ul style="list-style-type: none"> • Case Study (Is it OK to Ask? Or You Can't Do That!)
Leading with Principles	Become familiar with disciplinary codes of ethics	<ul style="list-style-type: none"> • Reviewing Codes of Ethics
	Articulate ethical issues in research and practice	<ul style="list-style-type: none"> • Case Study (Linking Public Data Set)
	Clarify their role in practicing ethical behavior and educating others about ethics	<ul style="list-style-type: none"> • Case Study (Abusive Workplace Behavior or A Drive in the Country)

adapted from the “Entering Mentoring” [40] and “Entering Research” [41] programs, in collaboration with the National Research Mentor Network (NRMN) [42] and the Center for the Improvement of Mentored Experiences in Research (CIMER) [43]. These foundational materials were publicly funded and extensively evaluated [44–48] with support from the NSF and National Institutes of Health, among others. The results reported here focus on the other 6 modules within the CyberAmbassadors program, which were developed “from scratch” for this project:

- Module 2. First Contact
- Module 3. It’s Complicated
- Module 4. Let’s Talk
- Module 5. Teaming Up
- Module 6. Leveling Up
- Module 7. Leading the Team

Table 2 summarizes the pilot testing data discussed in this paper, including the delivery type (online, in-person or hybrid); the numbers of respondents and participants; which of the two primary instructors delivered the training; and the module(s) delivered. All sessions were taught by one or both of the developers of the CyberAmbassador curriculum, and these pilot trainings were conducted between October 2018 and October 2019 in a variety of settings, including at conferences and universities. Several different training modalities were used; most common was in-person delivery, where the instructor(s) and participants were physically in the same location during the training. Two types of online training were used: “type 1” was fully online, with the instructor(s) and all participants connected remotely via videoconference; “type 2” had the instructor(s) participate via videoconference while the participants are physically together (typically when the training was incorporated into an existing event /class). Finally, several of the pilot sessions were conducted in a hybrid manner, where the instructor(s) were physically present with some participants, and other participants joined remotely via videoconference. These pilot sessions used Zoom videoconference software with desktop-sharing capabilities that allows participants to connect using their computer, tablet, or mobile phone.

Quantitative and qualitative data were gathered from surveys and observations (by a member of the research team). The survey includes sections on demographics (e.g., age, gender, educational background, work experience); on participants’ satisfaction with the curriculum content and training implementation; and on learning impacts of the training. Additionally, online audiences were asked to evaluate the use of videoconference as a professional skills training modality. Observational data focused on (1) host-learner interactions; (2) the effectiveness of teaching; and (3) participants’ reactions during the training. All items related to satisfaction and knowledge are measured by five-point Likert Scale, with (1) being very low and (5) being very high. The survey questions were developed using Kirkpatrick’s framework [49], which focuses on measuring participants’ reactions to the training experience and reporting learning gains. This study and our evaluation instruments were approved by Michigan State University’s Institutional Review Board; participation is voluntary and responses are made anonymously.

All instrument data were analyzed using the Statistical Package for the Social Science (SPSS). We created constructs based on the learning objectives of each module. In doing so, we conducted the reliability analysis to test internal consistency of each item using Cronbach’s alpha. We found that each scale is greater than 0.80; thus, the scale is reliable and appropriate for statistical analysis. After constructs were created, the differences between posttest and pretest scores were calculated to capture learning gains. The differences in learning gains between in-person, online, and hybrid groups were analyzed using independent t-test and a one-way ANOVA. Demographic background was analyzed using descriptive statistics.

4 RESULTS AND DISCUSSION

69 participants in the pilot sessions completed the evaluation survey, out of 393 participants (approximately 18% response rate). 42% of respondents participated in in-person training, 28% in online training, and 30% in hybrid training. Respondents ranged in age from 18 to 60, with 54% identifying as male. 88% of respondents completed college in the United States of America, and when asked about their highest educational achievement 25% reported bachelor’s degrees; 22% had master’s degrees; and 16% had earned a PhD. In addition, and of particular relevance to this project, 64% of the respondents had prior professional skills training experience. Of the online audiences, 79% of respondents had previously experienced online trainings.

Respondents were asked to rate their satisfaction with the training content, structure, and pace, as well as whether the overall training program met their expectations and whether they were willing to recommend this training to colleagues. Table 3 provides mean, variance, and the results of the F-test for these measures of satisfaction. We found that the hybrid group consistently reported a slightly higher satisfaction score, with the lowest variation among the three groups. Meanwhile, the online group had the lowest average score for each component, except for their satisfaction with the pace of the training. Our analysis found no significant differences at the $p < .05$ level for any of these satisfaction measures, suggesting that all participants, regardless of the training modality, were satisfied with the content, structure, and pace of the training. Overall, the CyberAmbassadors training also met their expectations and respondents were willing to recommend it to their colleagues. These quantitative results are supported by the open-ended, qualitative responses, which generally expressed appreciation and positive feedback. For example, one respondent shared that “I felt it was a very well-done training session, and really appreciated the warmth and networking with peers. The content was good, concise, and surprisingly novel!”

We sought satisfaction feedback because we were piloting this curriculum and wanted to modify it for maximum effectiveness. We also sought evidence of impact, and assessed how much participants learned (or believed they learned) from the training. Respondents were asked to assess their skills and knowledge before and after the training, and Table 4 presents mean, variance, and the results of the F-test for scales measuring changes in learning for each of the training modalities. Overall, the average improvement between

Table 2: Summary of Pilot Testing Sessions and Respondents

Group	Modalities	Respondents	Total Participants	Instructor	Module(s)
1	In-Person	8	12	A	5
2	Online (type 1)	5	25	B	5
3	Online (type 1)	11	28	B	3
4	In-Person	9	12	B	2, 3, 4
5.1	Hybrid	7	37	B	2, 3, 6
5.2	Hybrid	14	217	B	2, 4, 6
6	Online (type 2)	3	29	B	2, 3
7	In-Person	8	22	A&B	2, 3, 4, 7
8	In-Person	4	12	A	5
Total		69	393		

Table 3: Results of Satisfaction Measures

Measures of Satisfaction	Mean (St. Dev.)			F (Sig)
	In-Person	Online	Hybrid	
Satisfaction with the content	4.50 (0.611)	4.45 (0.724)	4.63 (0.567)	0.48 (0.620)
Satisfaction with the structure	4.34 (0.897)	4.32 (0.478)	4.60 (0.598)	0.98 (0.379)
Satisfaction with the pace	4.21 (0.774)	4.37 (0.597)	4.65 (0.587)	2.55 (0.860)
Does this program meet your expectations	4.41 (0.733)	4.33 (0.686)	4.71 (0.463)	1.98 (0.146)
Would you recommend this training to your colleagues?	4.48 (0.785)	4.47 (0.612)	4.52 (0.680)	0.03 (0.971)

Table 4: ANOVA One-Way Analysis

Module	In-person	Online	Hybrid	Total	F (Sig)
First Contact	1.18 (0.868)	1.78 (0.514)	0.94(0.712)	1.10 (0.78)	1.64 (0.207)
Let's Talk	0.75 (1.016)	0.33 (0.577)	1.03(0.908)	0.85 (0.935)	0.87 (0.428)
It's Complicated	0.95 (0.762)	0.65 (0.440)	-	0.85 (0.681)	1.59 (0.216)
Teaming Up	1.17 (0.795)	0.90 (0.224)	-	1.02 (0.533)	0.54 (0.486)
Leveling Up	-	-	0.92(0.878)	0.92 (0.878)	-
Overall Learning Improvement	0.94 (0.841)	0.73 (0.383)	0.96 (0.736)	0.89 (0.712)	0.57 (0.567)

post- and pre-test is 0.89, which indicates a positive gain on respondents' understanding and skills. The average improvement for the in-person and hybrid group is 0.94 and 0.96, respectively, while the average improvement for the online group was lower (0.73).

Independent t-tests and a one-way ANOVA were used to compare the learning improvements between the three groups. The results indicated no significant difference between the learning improvements in each module. Generally, there was also no significant difference at the $p < .05$ level for overall learning gains [$F(2,61)=0.537$, $p = 0.567$], although respondents reported an increase in knowledge and skills regardless of the training modality. Given the fact that the majority respondents were satisfied with the training experience, it is not surprising that they would also report gains in learning [49]. These results suggest that hybrid and online professional skills training can be as effective as in-person experience, when participants are satisfied with the training content and how the training was implemented. The qualitative responses suggest that many respondents found online training a good use of time and money and/or preferable for busy people who are unable to

travel. Videoconferencing was generally seen as an appropriate and effective medium for professional skills training – although a significant caveat is that the CyberAmbassadors curriculum is highly interactive, with small- and large-group activities regardless of the training modality. Participants who are using videoconferencing software were divided into groups for activities conducted in smaller videoconference “rooms” before being brought back into the main training (virtual) space.

5 NEXT STEPS AND FUTURE WORK

The CyberAmbassadors project is currently in its third and final year of funding, which focuses on finalizing the curriculum materials, training and supporting facilitators in disseminating the program, and preparing to transition program administration to collaborators who will ensure that the training remains accessible beyond the scope of the grant. A second cohort of 18 volunteer facilitators was trained at Michigan State University (MSU) in January 2020, and another facilitator training is planned for May 2020. The CyberAmbassadors training materials have also been adapted as a graduate-level course at MSU and facilitators from the Engineering

Futures [50] professional development program of Tau Beta Pi, the Engineering Honor Society, are in the process of adapting the materials for an audience of engineering students and professionals. In January 2020, the CyberAmbassadors program was also adapted for the first time for a non-STEM audience, when it was used to provide professional development training for the administrative staff at a non-profit organization.

The CyberAmbassadors research and evaluation team also continues to gather and evaluate data from the “regular” offerings of the training, now that the pilot studies have resulted in a stable curriculum. These results, along with separate evaluations of the “Train the Trainers” materials, will be disseminated as the project wraps up over the next year or so. In the longer term, we hope to partner with CIMER to host the CyberAmbassadors curriculum and evaluation materials, making them available free-of-charge to interested educators long after the project has come to a close.

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