

## PROJECT SUMMARY

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### **Overview:**

Elaborating on the NSF 2026 Idea Machine Reinventing Scientific Talent idea, we propose a conference to explore how short-format training (SFT), e.g. workshops, bootcamps, etc. can more effectively support career-spanning learning for researchers, educators, and other STEM professionals (STEM workforce). The proposed conference will assemble leaders from exemplar national-scale training programs, experts in education and adult learning, policy makers, and other stakeholders for “think-tank” style discussion. The proposed conference will approach problems described in the Reinventing Scientific Talent idea using the life sciences as a case study to explore 1) how SFT can be improved to serve career-spanning learning needs of the life science STEM workforce; and 2) how global SFT efforts that promote career-spanning training, including “workforce development”, can be leveraged. The conference will aim to develop pragmatic consensus recommendations as well as prioritized questions for future hypothesis-driven research. Starting from accepted educational research and the shared experience of the largest global programs for SFT, we have identified topics to stimulate broad community discussion in the life sciences and beyond. An Organizing Committee will further refine this list. To further the reach of the conference, a collaboratively developed white paper on these topics will be released as a living document for community development and dissemination. In this way, this conference has the potential to develop the first set of global consensus principles for SFT that serve career-spanning learning needs, relevant to life science and beyond. Participants (and the thousands of researchers and educators they serve globally) will also be strongly positioned to benefit from the resulting set of refined questions and hypotheses through further testing and development.

### **Intellectual Merit:**

Efforts to improve K-16 STEM education have not yet been matched by a similarly scaled effort to develop career-spanning learning and community of practice for the STEM workforce. In the life sciences, many in the STEM workforce struggle to incorporate computation, data science, and other skills not included in their formal preparation. Evidence suggests we are not doing enough to meet the needs of our skilled workforce. Training in various forms of computational skills and data integration tasks are the most unmet needs of NSF BIO-funded researchers (1) and less than a third of educators bring these skills to the classroom (with the most recently graduated educators being least likely to do so)(2). Although NSF and other agencies spend millions of dollars funding SFT, evidence(3) also suggests much of it may not have the intended effect. This conference will explore missed opportunities and challenges in applying established principles from education research, identify research gaps, define training successes and failures, and explore incentives/disincentives and mechanisms to incite culture change that supports career-spanning learning.

### **Broader Impacts:**

As described in the Reinventing Scientific Talent idea, members of the STEM workforce who cannot meet their career-spanning learning needs risk encountering artificial bottlenecks when they are unable to apply methods they have not been trained in but need to use. Educators risk being unable to provide students with up-to-date, job-ready skills. STEM professionals from underrepresented groups may suffer additional disparities when training is unavailable to them. This conference will address these issues by focusing on how training can be improved, evaluated, and scaled to better serve the needs of all researchers, with a strong focus on reaching the underserved.

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## RESULTS FROM PRIOR NSF SUPPORT

Jason Williams: **CyVerse (formerly iPlant Collaborative): Cyberinfrastructure for the Biological Sciences (EF-0735191 2/08-1/13, \$50,000, 000, Steve Goff, PI; DBI-1265383, 9/2013-8/2018, \$50,300,000, P. Antin, PI; DBI-1743442, 8/2018-7/2023, \$14,999,752, P. Antin, PI) Williams Role: Key Personnel** Intellectual Merit: CyVerse designs, develops, and supports a comprehensive cyberinfrastructure for life sciences. CyVerse has pioneered a scalable, extensible, federated architecture that directly serves a diverse community. It has produced technologies that power non-biology infrastructure such as Atmosphere Cloud and the Agave API. **Broader impact:** Over 70,000 users have registered for access to CyVerse data storage, cloud, and online analytical capabilities. More than 18,000 thousand have trained at workshops and webinars targeting graduate students, postdoctoral fellows, and principal investigators. **Publications:** Over 1,200 publications cite using CyVerse in their research, see cyverse.org for details.

Jason Williams and Rochelle Tractenberg: **RCN-UBE: Establishing a Genomics Education Alliance: Steps toward Sustainability (9/2018-8/2020, \$494,749; DBI 1827130) Chalker, Rosenwald, Tractenberg, Williams, Buonaccorsi PIs.** Intellectual Merit The Genomics Education Alliance (GEA) brings together members of existing genomics education networks to identify and curate common genome analysis tools, associated curricular and assessment materials, and faculty training strategies to facilitate the adoption of genomics instruction at any college or university. **Publications & Products** GEA has deployed a community survey to determine faculty needs and a series of pilot lessons (scalable BLAST, Genome Browsers, RNA-Seq in Jupyter notebooks) now being circulated via QUBEShub for faculty testing and feedback; no current publications. An Assessment Evaluation Rubric was developed and has been presented at national meetings (Whitepaper in progress). **Broader Impacts** GEA targets development of resources tailored to inclusion of faculty at minority serving institutions and community colleges. The second half of our implementation plan will further refine the pilot lessons for instruction at these targeted institutions.

Rochelle Tractenberg: Project/Proposal Title: **A multidimensional and dynamic ethics education paradigm spanning the science career.** Supporting Agency: NSF-EESE grant #1237590. Performance Period: 08/12–07/15, no cost extension to 08/16. Role on Project: PI Total Award Amount: \$273,000. **Intellectual Merit:** Discovered that significant disincentives exist nationally for university faculty to engage in portfolio creation relating to ethical reasoning/qualifications to mentor in ethics. Incentives for the current project are influenced by this experience. **Broader Impacts:** two peer reviewed papers, two white papers; five invited chapters; four contributions to Proceedings of the Joint Statistical Meetings (2013-2016); eight presentations at national (4) and international (4) meetings; and five posters at national (3) and international (2) meetings, listed fully in “List Of Products\_EESE1237590” appended to references.

## INTRODUCTION, INTELLECTUAL MERIT, AND STATEMENT OF NEED

Training and retraining workers for 21<sup>st</sup> century careers is a priority for the development of the U.S. workforce. Recently, the National Bureau of Economic Research concluded in its report *STEM Careers and the Changing Skill Requirements of Work*<sup>1</sup> that “STEM jobs change especially

quickly over time” and that “the faster rate of change in STEM is driven both by more rapid obsolescence of old skills and by faster adoption of new skills”. For example, this report concluded that STEM jobs requiring skills related to machine learning and artificial intelligence increased 460 percent between 2007 and 2017. The report also found that part of the reason why STEM workers are perceived to be in short supply is that “new technologies replace the skills and tasks originally learned by older graduates, causing them to experience flatter wage growth and eventually exit the STEM workforce. Faster technological progress creates a greater sense of shortage, but **it is the new STEM skills that are scarce, not the workers themselves.**” The report concludes that “the labor market impact of rapid technological change depends critically on the extent to which schooling and ‘lifelong learning’” can help build skills not only for the next generation, but for the skilled workforce we have already invested in creating.

Although efforts to train and retrain should include existing **researchers, educators, and other STEM professionals (STEM workforce)**, evidence shows we are not meeting the need for career-spanning learning for these groups. For example, a survey of 704 NSF-BIO-funded investigators revealed that training was the top 3 of 13 most unmet needs<sup>2</sup>. As successfully funded investigators the researchers who participated in this survey had excellent formal preparation and reported a high level of access to research infrastructure (e.g. high-performance computing, data storage, etc.). However, they still felt underprepared for the increasingly required tasks of data-driven research (for example training in integration of multiple data types was a need reported by 89% of respondents). The need for training is not limited to life sciences. Skill gaps frequently arise at the intersection of disciplines and this is being felt now with the increasingly rapid emergence of data science<sup>3</sup>. NSF has recognized this need and “Harnessing data for 21<sup>st</sup> century science and engineering” was first on NSF’s 2016 list of big ideas for future research<sup>4</sup>. Although specific needs differ across the sciences, data related skills gaps are also widely reported in chemistry<sup>5,6</sup> and the social sciences<sup>7</sup>. In physics<sup>8</sup>, collaboration, communication and other “soft skills” are most in demand.

The identified skill gaps persist despite interventions to address them. The rapid rate of change described in the *NBER* report supports the intuition that we should support interventions to keep secondary and undergraduate educational pipelines up to date but highlights that formal preparation will always lag behind in addressing the latest needs. While online learning can help fill the gap, Massive Open Online Courses (MOOCs) have fallen short<sup>9</sup>; often because they 1) suffer from low completion rates; 2) vary widely in scope, rigor, and approach; 3) persist even when content is in error or obsolete; and 4) present difficulties for learners when they wish to interact and ask questions, especially in large courses, or when offered asynchronously. We also know MOOCs do not serve diverse learners equally, continuing patterns of inequity<sup>10</sup>.

Another way members of the STEM workforce attempt to mitigate skill gaps is through **short-format training (e.g. workshops, boot camps, and short courses)**. **Short-format training (SFT)** is an appealing solution because it 1) provides point-of-need training where participants learn skills they can immediately bring into practice; 2) is often lower in time commitment and costs, making it more accessible than alternatives such as sabbaticals, online learning, or additional degrees; 3) is focused on either foundational skills or rapidly emerging techniques; and 4) is typically conducted in-person, providing for higher levels of interaction and support. These compelling advantages can make SFT the solution of choice for those in the STEM workforce wanting to

acquire or reinforce skills their original degrees did not prepare them with. Despite the prevalence of these training opportunities, workshops alone still cannot solve the skill gap challenge. The Feldon et.al.<sup>11</sup> analysis of 294 Ph.D. students in life sciences from 53 US institutions concluded that training in the form of boot camps and other short formats does not achieve the targeted learning objectives (skill development), nor do they demonstrate the desired impact in terms of “scientific workforce development”. This is concerning given more than \$28 million in investment from NSF and NIH in the support of these workshops. At the same time, several international organizations targeting STEM professionals have reported successful SFT outcomes. For example, *The Carpentries*<sup>12</sup> has reached more than 64,000 researchers through 2,562 workshops in 46 countries and assessment data suggests they are achieving sustainable impact. Their ability to accomplish this with an all-volunteer instructor core of more than 2,500 researchers also suggests both that SFT can be sustainable and can achieve global impact. The ELIXIR training program is also working to establish SFT assessment metrics for their pan-European program<sup>13</sup>. Both of these programs also seek to train educators to effectively develop and deliver impactful training. A comparison of training trainers and “users” of new techniques<sup>14</sup> identified nine dimensions where training trainers – which is usually effective and has long-term, career-spanning impact – and users, which is less effective at both, can be brought closer into alignment. While the SFT may succeed in introducing new tools and technologies for immediate practical application, what is not clear from these positive results is how they promote truly *career-spanning* development.

## CONFERENCE PLAN AND SPECIFIC AIMS

The NSF 2026 Idea Machine submission “Reinventing Scientific Talent”<sup>15</sup> was premised on the need to “combine the deep and slowly acquired expertise of a degree with novel approaches to training and learning that can enable individuals in the STEM workforce to refresh and reinvent themselves over the course of their careers.” The *Scientific Talent* idea developed the life sciences as a case study in how rapid appearance of new skills (in the example case computation and data science) lead to skills gaps and result in divides within a discipline where critical methodologies may end up in the hands – and skillsets – of a few.

To elaborate on the *Scientific Talent* idea, we propose a conference to explore **1) how short-format training can be improved to serve career-spanning learning needs of a diverse life science STEM workforce; and 2) how global SFT efforts that promote career-spanning “workforce development” can be connected into an inclusive community of practice framework.** The conference will aim to **develop pragmatic consensus recommendations as well as prioritized questions for future hypothesis-driven research.** Focusing the conference on life science provides several advantages. First, life science is itself highly interdisciplinary and its intersection with computer and data science (including mathematics and statistics) presents a recognized need for career-spanning skill acquisition. Secondly, life science jobs are a fast-growing component of the U.S. workforce with more than 1.2 million employed in various sectors in addition to educators and related STEM professionals<sup>16</sup>. Finally, there are currently several national-scale SFT providers in the US and abroad (e.g. *The Galaxy Training Network*<sup>17</sup>, *ELIXIR Training*<sup>18</sup>, *GOBLET*<sup>19</sup>, *Australian BioCommons*<sup>20</sup>, *The Carpentries*<sup>12</sup>, *CSHL Meetings*<sup>21</sup>, *CSHL DNA Learning Center*<sup>22</sup>, *LifeSciTrainers*<sup>23</sup>, etc.) that not only represent a wealth of practical expertise, but can also serve as potential testbeds for the recommendations and hypothesis-driven research questions this conference will explore. This conference will bring together both

communities and individuals that have not previously worked together, as well as collaborations that have developed experience in aligning international efforts and stakeholders. This conference will therefore stimulate broad discussion of the topics raised by the *Scientific Talent* idea – identifying successful consensus practices, challenges, and priority research questions that can generalize to, and guide improvements of, career-spanning learning for STEM workforce in all the sciences.

To achieve these results, we have developed the following Specific Aims:

1. Convene an Organizing Committee to refine conference themes and assemble an interdisciplinary and diverse set of participants
2. Hold an inclusive and discussion-focused conference at the CSHL Banbury Center
3. Collaboratively develop a living report to engage the community in feedback and discussion and broadly disseminate findings
4. Hold a virtual community debriefing meeting to stimulate feedback on conference proceedings and evaluate opportunities for follow up activities

The proposed conference will be a discussion-focused event in the Banbury Center’s proven think tank-style format. The 2.5 day event will include 25 in-person attendees (not including PIs): 6 organizing committee members (including one CSHL staff), 17 additional attendees. Additional attendees will also have full virtual participation options described below.

### **Aim 1: Convene an Organizing Committee to refine conference themes and assemble an interdisciplinary and diverse set of participants**

We have assembled a small **Organizing Committee (OC)** that represents deep expertise in education, training, and life sciences. The Organizing Committee will: 1) nominate additional attendees to the conference; 2) select additional attendees from a pool of candidates who apply to attend in-person/virtually; 3) chair/co-chair sessions; 4) co-author publications; and 4) make decisions on any content-related matters. This OC also represents a diversity of domain expertise, career stages, and gender and ethnic diversity.

**Jason Williams (PI)** is Assistant Director, External Collaborations at the CSHL DNA Learning Center (DNALC). The DNA Learning Center has trained thousands of high school and undergraduate educators in the U.S. and abroad, and over the past 30 years has pioneered lab and computer-based curricula. In his role at the DNALC, Williams has led education, outreach, and training for CyVerse (NSF-funded cyberinfrastructure for the life sciences) and trained thousands of researchers and educators in bioinformatics, data science, and molecular biology. Williams is also the author of the *Reinventing Scientific Talent* Idea and is also the founder of LifeSciTrainers.org – a global effort to promote community of practice among professionals who develop training for other life scientists. He is Chair of the Advisory Group for the Australian BioCommons’s training efforts, and has advisory roles on data science cyberinfrastructure, and training efforts at NIH and the Pan-European Bioinformatics Organization’s UK node (ELIXIR UK).

**Rochelle Tractenberg (Co-PI)** is a tenured professor at Georgetown University. An American Statistical Association - Accredited Professional Statistician<sup>®</sup>, she is also a cognitive scientist who has engaged in higher education/curriculum development research and training for over 25 years. She created the curriculum development and evaluation tool, the Mastery Rubric, in 2005 and published the Mastery Rubric for Bioinformatics<sup>24</sup> with her collaborators across Europe in 2019. Mastery Rubrics are particularly well-suited to career-spanning training, and engaging learners in their own ongoing growth and development prior to/beyond the end of instruction. Dr. Tractenberg has served on the Training Advisory Group for the European Molecular Biology Laboratory (EMBL)- European Bioinformatics Institute (2016-2018) and the EMBL-Australian Bioinformatics Resource Steering Committee (2017-2019), and on the Learning, Education, and Training (LET) Committee of the Global Organisation for Bioinformatics Learning, Education and Training (GOBLET) since 2016. She was a co-investigator on the NIH BD2K grant, creating the single national training coordinating center and has consulted on the ELIXIR Train the Trainer program since its kick-off in January 2016. She currently Chairs the Assessment Committee on the NSF RCN-UBE: *Establishing a Genomics Education Alliance: Steps toward Sustainability* (NSF-DEB, award #1827130). She brings a unique background in cognitive scientific perspectives on higher education, combined with a 20+ year career in data-intensive science and quantitative practice, and extensive experience training future faculty (Ph.D. students in the Social Sciences, 2003-2006) and faculty (since 2010) in teaching, learning, and assessing across the life science career.

**Samuel Donovan** is a Ph.D. trained science educator (2005, University of Wisconsin-Madison) who is a full-time lecturer in the Department of Biological Sciences at the University of Pittsburgh. He has played a leadership role in a series of national STEM education reform efforts including the BioQUEST Curriculum Consortium, the BEDROCK bioinformatics education project, National Science Digital Library, and was a contributing author to the *Vision and Change* report. Dr. Donovan is currently PI of the NSF funded Quantitative Undergraduate Biology Education and Synthesis (QUBES; qubeshub.org) educational cyberinfrastructure project. QUBES focuses on community driven biology faculty professional development and educational scholarship and helps over 80 reform projects collaborate, disseminate, and sustain their efforts.

**Celia van Gelder** is Training Programme Manager of the Dutch Techcentre for Life Sciences (DTL), which is also the Dutch node of ELIXIR (ELIXIR-NL). She is a bioinformatics education manager, coordinator and trainer with extensive experience in initiating and managing bioinformatics education and training projects at institute, national, and international level. Target audiences for her training projects include high school students and teachers, B.Sc. and M.Sc. students, Ph.D. students and other life science researchers. She is co-lead of the ELIXIR Training Platform, that aims to build a sustainable training infrastructure in Europe. The Platform has built a community of trainers across the 23 ELIXIR Nodes, offers the portal TeSS to register training materials and events and has implemented a “Quality & Impact” strategy. The Platform also strengthens national training programmes and helps develop training capacity in the ELIXIR Nodes, and by a train-the-trainer programme. In the global arena of bioinformatics training Celia is Chair of GOBLET, the Global Organisation for Bioinformatics Learning, Education and Training. Recently, she was appointed as member of the Working Group Training & Skills of the EOSC (European Open Science Cloud).

**B er nice Batut** holds a Ph.D. in computational biology and is currently a postdoctoral researcher at the University of Freiburg, Germany (Galaxy Team). Her current focus is co-leading the Galaxy Training Material project, a community effort that she created to freely provide high quality hands-on training material for data analysis in life science. The >150 tutorials supported by a strong training infrastructure (tools, data, servers) are daily used for self-learning and short-format training. These materials are used globally through the Galaxy Training Network<sup>16</sup>. Dr. Batut is also an international trainer and a lecturer in bioinformatics and computer science as well as the deputy training coordinator for ELIXIR Germany (de.NBI) and a Mozilla Open Leader. She also co-founded Open Life Science, an online 15-week mentoring and training program for Open Science ambassadors in Life Science.

**Charla Lambert** Holds a Ph.D. in Genome Sciences from the University of Washington and has been PI/co-PI on a variety of educational grants, including an NIH IPERT grant that was focused on scientific training, mentoring, outreach, and community building for CSHL's postgraduate short course program. Dr. Lambert splits her time between helping to maintain the academic offerings organized by CSHL's Meetings & Courses Program, and directing CSHL's Office of Diversity, Equity, & Inclusion (DEI). Through the DEI office, she integrates and oversees efforts across multiple divisions to promote equitable and inclusive working environments on campus; these efforts often involve organizing and leading educational seminars, workshops, and trainings on various DEI topics. Through the CSHL Meetings & Courses Program, she focuses on grant writing, curriculum development, and assessment for small conferences, courses, and workshops, particularly those in the areas of bioinformatics/computational biology, genomics, and professional development for biomedical scientists (e.g., leadership and communication skills). Nationally, Dr. Lambert has served on the Board of Directors for SACNAS, the Society for Advancement of Chicanos/Hispanics and Native Americans in Science.

**Kari L Jordan** Holds both B.S. and M.S. degrees in Mechanical Engineering from Michigan Technological University, and Ph.D. from *The Ohio State University* in Science, Technology, Engineering, and Mathematics (STEM) Education as well as an M.A. in Art Education. She has served as the President of the Ohio Diversity Council and on the Board of Directors for the *National Society of Black Engineers* (NSBE). Currently, Dr. Jordan is the Acting Executive Director for *The Carpentries* and is responsible for the overall management and direction of the organization in accordance with its vision and mission. Previously she also served as *The Carpentries* Senior Director of Equity and Assessment. Kari also founded and is the founder of *Engineer like a Girl*, an academic and leadership program that prepares female students from diverse backgrounds to pursue a career in engineering.

**Teresa Mourad** is Director of Education and Diversity Programs at the Ecological Society of America. She has more than two decades of nonprofit management experience including program development, fundraising, membership development, event planning and grants management. Teresa leads several programs to diversify the field of ecology, increase access and discovery of education resources and build career development opportunities. She directs ESA's Presidential award-winning *SEEDS* undergraduate diversity mentoring program, and the EcologyPlus project, an *NSF INCLUDES* pilot using collective impact approaches to support diverse students and recent graduates in ecology career pathways. Her recent focus has been on faculty programs that support the development and implementation of data-rich and inclusive curricula and the ESA-endorsed

Four Dimensional Ecology Education framework. She holds a B.A. in Sociology and English Literature and a M.S. in Environmental Education.

**Tracy Teal** is the Executive Director of Dryad and previously the Executive Director of The Carpentries and a co-founder of Data Carpentry. She has a background in microbiology and bioinformatics with a Ph.D. in Computation and Neural Systems from California Institute of Technology and NSF Postdoctoral Fellowship in Biological Informatics. She serves on several advisory groups including the University of Colorado Boulder Earth Lab External Advisory Board, Code for Science and Society Conference Fund Advisory Committee, NSF-INCLUDES Environmental Data Science Inclusion Network advisory committee and the Organization for Economic Co-operation and Development Expert Group on Digital Skills for Data Intensive Science. She has directed several bioinformatics short-courses including as a current co-director of the Marine Biological Laboratory course, Strategies and Techniques for the Analysis of Microbial Populations (STAMPS). With *The Carpentries* she directed the collaborative development of openly licensed curricula and through a volunteer instructor program, facilitated the scaling of interactive, inclusive training to researchers worldwide with more than 600 workshops, reaching more than 15,000 learners in 2019 alone. In her role at Dryad, she continues her work in democratizing data, working to bring people to data and data to people, to empower people to answer the questions that are important to them.

To further promote diversity and divergent thinking, we also anticipate inviting 1-2 additional experts from outside the life sciences to participate as organizers.

### **Organizing Committee Responsibilities and Activities:**

**Activity 1A: Hold committee meetings and participate in decision making** Prior to the main conference, the OC will meet virtually as needed to refine session topics and to finalize selection of nominated and invited applicants. PI Williams along with Co-PI Tractenberg will chair and convene these meetings and distribute agendas and materials in advance. They will coordinate with Banbury Center staff and the director (Aim 2) to keep this group informed of all logistical matters. All decisions about conference proceedings will be by majority vote with PI Williams breaking ties as needed. This group will also ratify the conference code of conduct and any related policies. It will also determine authorship and make decisions on mechanisms of advertising and dissemination. Williams and Tractenberg will also be responsible for reporting responsibilities to NSF.

**Activity 1B: Manage participant recruitment** To ensure diversity of ideas and participants, approximately one-third of seats will be reserved for participants recruited through a widely advertised application, while the OC will nominate the remaining participants. An application form will be designed and approved by the OC within one month of this project's start date (application will include the final meeting date). The application procedure will be advertised online including through social media and through various networks and professional societies. Participants will be selected by early November 2020 (target conference date early 2021), on the basis of their expertise and contributions to relevant areas of research or professional practice. Priority will be given to participants with less overlap in areas of expertise represented by the OC and nominated

participants, and who add to the conference's gender, ethnic, and racial diversity. We will also selectively recruit a small number of attendees (virtual and in-person) from policymaking and funding agencies or bodies.

**Activity 1C: Chair/Co-Chair conference sessions and contribute to conference proceedings** Each OC member is responsible for chairing/co-chairing a conference session aligned with their expertise. We anticipate 6-8 distinct, sequential sessions emerging from identified themes (Aim 2). OC members will chair/co-chair these sessions during the meeting. They will also nominate participants and balance the makeup of the sessions. The final conference sessions will inform sections in a proceedings white paper; chairs/co-chairs will be responsible for leading authorship of their section, in collaboration with their session speakers, attendees, and a science writer who will document sessions and provide writing and editorial support (see Aim 3).

## **Aim 2: Hold an inclusive and discussion-focused conference at the CSHL Banbury Center**

In early 2021 we will host the 2.5-day conference (approximately 25 in-person attendees, an estimated 10 additional full-virtual-participation attendees, and several virtual attendees who may elect to view individual sessions) at the Cold Spring Harbor Laboratory Banbury Center. Since its opening in 1978, the Banbury Center has convened more than 650 meetings for small groups of invited experts on a broad array of technical, policy and educational topics across the biosciences, including for example meetings that led to the development of *Arabidopsis* as the model species for plant genomics<sup>25</sup>, the human genome project<sup>26</sup>, and the *Innocence Project*<sup>27</sup>. Each session will address the identified topics/themes (see below for preliminary list, to be refined by OC) and will be chaired by a thought leader on the subject. Sessions will be limited to ~1.5 hours—60 minutes of talks and 30 minutes of discussion and synthesis moderated by the chair.

**Overall meeting features** Banbury Center meetings are small gatherings with speaking roles for most attendees. There are no evening sessions, so participants have ample time for informal discussion. Importantly, efforts are made to invite attendees who are relevant to the topics, but who would be new or unknown to the organizers' circle of collaborators. Diversity and gender representation are also explicit concerns for invitees. The meeting code-of-conduct (Activity 1A) will also communicate the conference's commitment to inclusion. Travel support and subsistence will be provided to attendees housed on the Banbury campus. Banbury Center staff will coordinate abstract submissions, travel arrangements, and any other administrative and logistical details. We will work with attendees on an individual basis to support needs for childcare, accessibility, sign-language translation, or other support. We will work with speakers and provide recommendations to increase the accessibility of their presentations. Attendee abstracts and suggested readings will be circulated in advance of the meeting.

**Virtual attendance** To further increase the diversity of participant perspectives and backgrounds, we will also offer virtual participation. Virtual participants must commit to attendance of all scheduled sessions (with limited exceptions for some international participants and/or participants from funding or policymaking organizations). During periods with no scheduled sessions, breakout meeting rooms will be available so virtual participants can also join in-person attendees in spontaneous breakouts.

**Audiences and conference topics** Based on the literature search and discussion with the OC, a set of broad preliminary topics have been identified. We expect this list to evolve as additional OC members and workshop participants are recruited. The two primary audiences for this workshop include 1) policy and decision makers (e.g. institutions and funders who can use workshop outcomes to inform how to allocate resources that support training); and 2) training providers (e.g. individuals, institutions, societies, etc. that develop learning materials and curriculum for SFT). In light of these audiences, topics are formulated as broad questions that will center discussions on identifying pragmatic outcomes including proven approaches that have not been applied to career-spanning learning for STEM professionals (but could), and research questions that have not been addressed by current efforts (but could be developed to support hypothesis-driven research). In commitment to broader impacts, we have also considered the National Science Board’s report: “*The Skilled Technical Workforce [STW]: Crafting America’s Science & Engineering Enterprise*”<sup>28</sup> in developing conference topics. This report concludes that “which programs are most effective at preparing students for the workforce” and “how people use their skills once they enter the workforce” are still areas where “policymakers, industry, and educational institutions have taken steps to address changing workforce needs by introducing new policies and programs geared toward the STW [and that] much of this activity is...occurring in the context of limited or siloed data.” The report also comments that “addressing data gaps and silos will be essential if the United States is to take a strategic, systems-level approach to cultivating the STW.” Importantly, these topics also are significantly broader in scope than the efforts of existing societies and groups which often have more narrowly scoped audiences or funded mandates.

### **1. Successful Training at Scale**

1. How do we define success (and failure) in SFT?
2. Are there differences between SFT programs in and outside of academia?
3. Are differences between SFT programs for instructors (train the trainer) and users (researchers) important; do they impact the long-term effects/impact?
4. How can/do successful SFT programs meet *career-spanning* learning needs?

### **2. Research Gaps**

1. How can we assess the long-term impacts of individual SFT events/programs?
2. How can we prepare learners to assess the impacts of individual SFT events for their own workforce/professional development objectives?
3. Is there a pragmatic path to scaling advanced/specialized training?
4. How can SFT be best scaffolded within the career-spanning learning landscape?

### **3. Incentivizing and Enabling Training**

1. How can career-spanning learning be supported across professional contexts?
2. What is the role of funders, institutions, and professional societies in fostering communities of practice that promote and support career-spanning learning?
3. How can short format training be a force for equity and inclusion in STEM?
4. What e-infrastructure is needed to support this effort?

#### 4. Culture Change

1. How can a community of practice be effective in promoting career-spanning learning?
2. How can we create scale-independent culture change across scientific communities and disciplines?
3. How can we encourage adoption of evidence-based practices for teaching and learning across disciplinary, institutional, and geographic borders?
4. How can the established findings of educational research be leveraged to support culture change, and mitigate resistance and other obstacles?

**Current meetings that overlap with these topics** Referral to the literature and consultation with the OC did not yield any planned, existing, or past (last 10 years) conferences focused on the proposed topic space and with a focus on solving the challenges to scalable, community-of-practice-based career-spanning learning for the STEM workforce. Many potentially similar conferences (several funded by NSF-EHR/DRL) focused on postgraduate education of the STEM workforce to improve K-12/undergraduate education. Additional conferences focused on retention in STEM, especially in addressing discrimination. We do note that professional societies are often an important source of professional development for the STEM workforce and OC member *Mourad* helps bring that experience to our discussion. However, we have not identified conferences which explored the coordinated effort to share and create community of practice, identify research questions, and address obstacles to career-spanning learning at scale. The following was the only conference we identified with at least a few similar objectives:

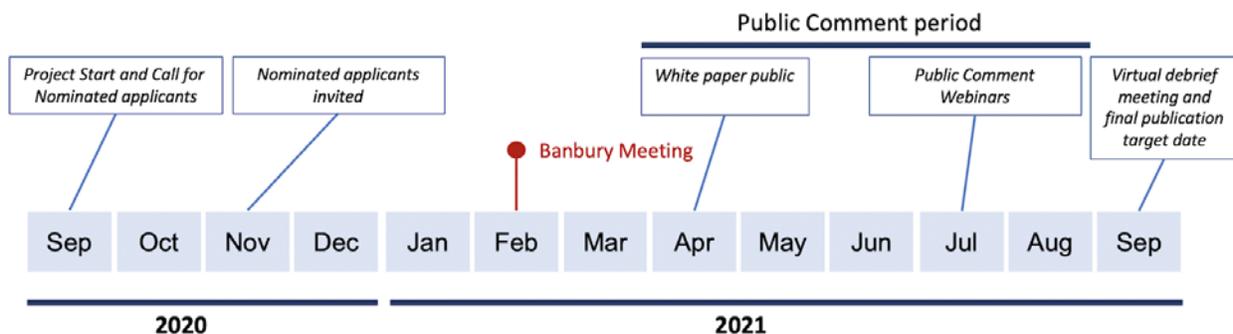
Conference	Date	Notes	Outputs
Lifelong Learning in the Biomedical Sciences (Heidelberg, Germany)	July, 2016	Organized by EMBL (European Molecular Biology Laboratory) in Heidelberg, this conference explored professional development for EMBL researchers and to support biomedical research <sup>29</sup> .	This conference was not developed to explore specific research questions, and no specific publications that were used to disseminate its content. The conference included a single session on practice as applies directly to those doing training in the life sciences (with similarities to our 2.1 conference topic). We believe this meeting compliments and informs our proceedings but does not substantially overlap. ELIXIR training was the focus of this discussion and OC member Van Gelder Co-leads the ELIXIR training platform.

**Aim 3: Collaboratively develop a living report to engage the community in feedback and discussion and broadly disseminate findings**

**Dissemination and Contribution Plan** We have budgeted a modest amount for a science writer who will attend the meeting and document the proceedings of each session from an informed perspective. After the meeting, the journalist will also provide limited assistance to each of the chairs, working with the OC to produce a proceedings white paper. Each white paper section will include: 1) a statement of the problem and its background; and 2) a set of recommendations (i.e. processes, pedagogical approaches, technologies) and/or open questions to the community. This publication will be circulated as a preprint and on GitHub for community comment. We will also publicize the document online and through our professional networks to garner as much feedback as possible. PI Williams will hold a webinar for LifeSciTrainers.org’s 300+ members from more than 20 countries, all of whom provide training in the life sciences. The goals of this dissemination effort will be both to widely share the document, and also to **solicit community feedback with the offer of co-authorship for substantial contributions** (as defined in advance by ICMJE authorship rules<sup>30</sup>, and subject to final approval by the PIs). In this way we will extend the reach of the conference and develop recommendations and refined research questions that can plausibly represent community consensus. After the comment period, the OC will address and incorporate feedback, and work with any identified co-authors to decide on additional publication venues. The OC will also develop the proceedings of this work into talks to further disseminate findings. OC members each have potential outreach networks where findings can be disseminated, and we will encourage this sharing.

**Aim 4: Hold a virtual community debriefing meeting to stimulate feedback on conference proceedings and evaluate opportunities for follow up activities**

The OC and attendees are engaged in life sciences, the preparation of the life sciences workforce, and general efforts to train life scientists throughout their careers. In the final month of the period of performance, we will hold a virtual meeting (~ half-day), open to attendees of the Banbury Center conference and other interested community members. The purpose of this meeting will be to explore and potentially provide evidence of how conference topics and recommendations have been received by the communities and organizations of attendees. We will also explore opportunities for future collaborations and projects on implementation of findings, and the potential for funding for interventions, pilot implementations, and additional meetings/conferences.



**Figure 1 - Project Timeline.** We currently anticipate scheduling the Banbury Center meeting for early 2021 (with the caveat that the current COVID-19 situation is affecting conference plans and scheduling one year out). We have reserved space at the Banbury Center, but dates presented above

may be shifted slightly. Every effort will be made to allow for the maximum time possible for participant applications to the conference and public comment.

## **BROADER IMPACTS**

Anticipated broader impacts aligned with PPAG example questions:

### **How well does the activity advance discovery and understanding while promoting teaching, training, and learning?**

In addition to proposing topics we believe will uncover research questions of intellectual merit, we also plan to include topics to generate pragmatic consensus recommendations that can be implemented across contexts, including train-the-trainer, train-the-user, academic and workforce development SFT programs. The attendees will have practical and intellectual excellence in training from diverse groups. This conference will bring together currently unconnected efforts, providing an unprecedented forum for the development of findings that can achieve broad community endorsement and laying the foundation for transformative impact on how training is approached in the life sciences and beyond.

### **How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?**

In harmony with the *Reinventing Scientific Talent* idea, a goal is to provide additional opportunities that can enhance the ability for professionals to acquire skills that mitigate disparities they face, increase the impact and competitiveness of their research proposals when applicable, and enhance their career mobility. One of the conference topics (3.3) specifically seeks to address how better training can enable broader participation and support faculty opportunity and retention. We have reflected this commitment to diversity in the composition of the OC and will also prioritize diversity in the final selection of attendees.

### **Will the results be disseminated broadly to enhance scientific and technological understanding?**

The small conference format provides the opportunity to develop discussion opportunities a larger conference would not afford. This also potentially has the effect of not capturing evidence or points of view that may be overlooked in larger settings. We therefore will have an extended dissemination phase where the draft conference white paper will be circulated to capture responses from as broad an audience as possible. This feedback will be incorporated into formal publications, making them readily available to all. The white paper will be a living document developed in an open format (GitHub) that will stimulate further community action and discussion. Conference attendees will also be disseminators within their respective professional communities, broadening the reach to those who might not learn of the white paper in other ways. We will also identify and reach out to communities outside the life sciences – through publication venues, organizations, and social media – who can contribute feedback to the white paper or who may benefit from being aware of its recommendations and findings.

**What may be the benefits of the proposed activity to society?**

Also in harmony with the *Reinventing Scientific Talent* idea, the goal of improving career-spanning learning for STEM workforce is to enable the skilled professionals we have already created to be better prepared for the next transformative advance in their discipline. When the next equivalent of CRISPR or machine learning appears, it could arrive within a STEM workforce that is better equipped to make use of that approach to deliver benefits to society more quickly and with higher impact. By providing lifelong learners with tools to meet emerging needs, we anticipate that these more competitive workers will be retained in their field, reducing attrition and contributing to the growing need for skilled workers in the STEM workforce.

## PROJECT SUMMARY REFERENCES

1. Barone, L., Williams, J., & Micklos, D. (2017). Unmet needs for analyzing biological big data: A survey of 704 NSF principal investigators. *PLoS Comput Biol*, 13(10), e1005755. doi:10.1371/journal.pcbi.1005755
2. Williams, J. J., Drew, J. C., Galindo-Gonzalez, S., Robic, S., Dinsdale, E., Morgan, W. R., . . . Pauley, M. A. (2019). Barriers to integration of bioinformatics into undergraduate life sciences education: A national study of US life sciences faculty uncover significant barriers to integrating bioinformatics into undergraduate instruction. *PLOS ONE*, 14(11), e0224288. doi:10.1371/journal.pone.0224288
3. Feldon, D. F., Jeong, S., Peugh, J., Roksa, J., Maahs-Fladung, C., Shenoy, A., & Oliva, M. (2017). Null effects of boot camps and short-format training for PhD students in life sciences. *Proceedings of the National Academy of Sciences*, 114(37), 9854-9858. doi:10.1073/pnas.1705783114

## MAIN NARRATIVE REFERENCES

1. Deming, D. J., & Kadeem, N. L. (2019). STEM Careers and the Changing Skill Requirements of Work (Working Paper 25065). Retrieved from <http://www.nber.org/papers/w25065>
2. Barone, L., Williams, J., & Micklos, D. (2017). Unmet needs for analyzing biological big data: A survey of 704 NSF principal investigators. *PLoS Comput Biol*, 13(10), e1005755. doi:10.1371/journal.pcbi.1005755
3. Veaux, R. D. D., Agarwal, M., Averett, M., Baumer, B. S., Bray, A., Bressoud, T. C., . . . Ye, P. (2017). Curriculum Guidelines for Undergraduate Programs in Data Science. *Annual Review of Statistics and Its Application*, 4(1), 15-30. doi:10.1146/annurev-statistics-060116-053930
4. National Science Foundation (2017). NSF's 10 Big Ideas. Retrieved from [https://www.nsf.gov/news/special\\_reports/big\\_ideas/](https://www.nsf.gov/news/special_reports/big_ideas/)
5. Kondo, A. E., & Fair, J. D. (2017). Insight into the Chemistry Skills Gap: The Duality between Expected and Desired Skills. *Journal of Chemical Education*, 94(3), 304-310. doi:10.1021/acs.jchemed.6b00566
6. Handon, S., & Overton, T. (2010). Skills required by new chemistry graduates and their development in degree programmes. Retrieved from <http://www.rsc.org/learn-chemistry/resources/business-skills-and-commercial-awareness-for-chemists/docs/skillsdoc1.pdf>
7. Lapointe, S., & Turner, J. (2020). Leveraging the Skills of Social Sciences and Humanities Graduates. Retrieved from <https://fsc-ccf.ca/wp-content/uploads/2020/01/UniversityGraduateSkillsGap-PPF-JAN2020-EN-FINAL.pdf>
8. Heron, P., & McNeil, L. (2016). Phys21:Preparing Physics Students for 21st-Century CareersPreparing Physics Retrieved from [https://www.compadre.org/JTUPP/docs/J-Tupp\\_Report.pdf](https://www.compadre.org/JTUPP/docs/J-Tupp_Report.pdf)
9. Reich, J., & Ruipérez-Valiente, J. A. (2019). The MOOC pivot. *Science*, 363(6423), 130-131. doi:10.1126/science.aav7958
10. DeBoer, J., Seaton, D., Stump, G. S., & Breslow, L. (2013). Diversity in MOOC Students' Backgrounds and Behaviors in Relationship to Performance in 6.002x.

- Proceedings of the sixth learning international networks consortium conference, 4, 16-19. Retrieved from <https://linc.mit.edu/linc2013/proceedings/Session2/Session2DeBoer-Stump.pdf>
11. Feldon, D. F., Jeong, S., Peugh, J., Roksa, J., Maahs-Fladung, C., Shenoy, A., & Oliva, M. (2017). Null effects of boot camps and short-format training for PhD students in life sciences. *Proceedings of the National Academy of Sciences*, 114(37), 9854-9858. doi:10.1073/pnas.1705783114
  12. Teal, T. K., Cranston, K. A., Lapp, H., White, E., Wilson, G., Ram, K., & Pawlik, A. (2015). Data Carpentry: Workshops to Increase Data Literacy for Researchers *International Journal of Digital Curation*, 10(1). doi:<https://doi.org/10.2218/ijdc.v10i1.351>
  13. Gurwitz, K. T. "A framework to assess the quality and impact of bioinformatics training across ELIXIR". Submitted to *PLOS Computational Biology*
  14. Tractenberg, RE. (2018, August 10). Achieving sustainability and transfer with short term learning experiences. <https://doi.org/10.31235/osf.io/jsfe9>
  15. Williams, J. (2019). Reinventing Scientific Talent. Retrieved from <https://nsf2026imgallery.skild.com/entries/reinventing-scientific-talent>
  16. Kennedy, J. (2018). Strong action is needed to preserve the competitiveness of America's life-science industries. Retrieved from <https://www.statnews.com/2018/05/07/life-sciences-america-preserve-competition/>
  17. Blank, C., Easterly, C., Gruening, B., Johnson, J., Kolmeder, C. A., Kumar, P., May, D., Mehta, S., Mesuere, B., Brown, Z., Elias, J. E., Hervey, W. J., McGowan, T., Muth, T., Nunn, B., Rudney, J., Tanca, A., Griffin, T. J., & Jagtap, P. D. (2018). Disseminating Metaproteomic Informatics Capabilities and Knowledge Using the Galaxy-P Framework. *Proteomes*, 6(1), 7. <https://doi.org/10.3390/proteomes6010007>
  18. Via, A., Attwood, T. K., Fernandes, P. L., Morgan, S. L., Schneider, M. V., Palagi, P. M., . . . Tractenberg, R. E. (2017). A new pan-European Train-the-Trainer programme for bioinformatics: pilot results on feasibility, utility and sustainability of learning. *Briefings in Bioinformatics*, 20(2), 405-415. doi:10.1093/bib/bbx112
  19. Atwood, T. K., Bongcam-Rudloff, E., Brazas, M. E., Corpas, M., Gaudet, P., Lewitter, F., . . . Consortium, G. (2015). GOBLET: The Global Organisation for Bioinformatics Learning, Education and Training. *PLoS Computational Biology*, 11(4). doi:10.1371/journal.pcbi.1004143
  20. Australian BioCommons. Retrieved from <https://www.biocommons.org.au/training>
  21. Cold Spring Harbor Laboratory Meetings and Courses. Retrieved from <https://meetings.cshl.edu/>
  22. Cold Spring Harbor Laboratory DNA Learning Center. Retrieved from <https://dnalc.cshl.edu/about/index.html>
  23. LifeSci Trainers. Retrieved from <https://lifescitrainers.org/>
  24. Tractenberg, R. E., Lindvall, J. M., Attwood, T. K., & Via, A. (2019). The Mastery Rubric for Bioinformatics: A tool to support design and evaluation of career-spanning education and training. *PLOS ONE*, 14(11), e0225256. doi:10.1371/journal.pone.0225256
  25. Somerville, C., & Koornneef, M. (2002). A fortunate choice: the history of Arabidopsis as a model plant. *Nature Reviews Genetics*, 3(11), 883-889. doi:10.1038/nrg927

26. Green, E., Watson J.D., Collins, F. S. (2015) Human Genome Project: Twenty-five years of big biology. *Nature*, 526(7672), 29-31.
27. Gitschier, J. (2013). The Innocence Project at Twenty: An Interview with Barry Scheck. *PLOS Genetics*, 9(8), e1003692. doi:10.1371/journal.pgen.1003692
28. National Science Board. (2019). The Skilled Technical Workforce: Crafting America's Science & Engineering Enterprise (NSB-2019-23). Retrieved from <https://www.nsf.gov/nsb/publications/2019/nsb201923.pdf>
29. EMBL. (2016). Lifelong Learning in the Biomedical Sciences. Retrieved from <https://www.embl.de/training/events/2016/LLL16-01/>
30. International Committee of Medical Journal Editors. Retrieved from: <http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html>

### **References from Current and Pending Support**

#### **Peer-reviewed papers**

1. Tractenberg RE, Russell A, Morgan G, FitzGerald KT, Collmann J, Vinsel L, Steinmann M, Dolling LM. (2015) Amplifying the reach and resonance of ethical codes of conduct through ethical reasoning: preparation of Big Data users for professional practice. *Science and Engineering Ethics* <http://link.springer.com/article/10.1007%2Fs11948-014-9613-1>
2. Tractenberg RE. (2015). (Book Review). Review of AT Panter, SK Sterba (Eds.) "Handbook of Ethics in Quantitative Methodology" and National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, "On Being A Scientist: A Guide to Responsible Conduct in Research. 3E." *The American Statistician*. Doi: 10.1080/00031305.2015.1068620
3. Tractenberg RE, FitzGerald KT, & Collmann J. (2017). Evidence of sustainable learning with the Mastery Rubric for Ethical Reasoning. *Education Sciences*. Special Issue: Consequential Assessment of Student Learning. *Educ. Sci.* 2017, 7(1), 2; doi:10.3390/educsci7010002 <http://www.mdpi.com/2227-7102/7/1/2>

#### **White Papers**

1. Tractenberg RE, FitzGerald KT, Collmann, Giordano J. (2014) Big data impact upon neuroS/T use for influence and deterrence. In: DiEuliis D, Casebeer W, Giordano J, Wright N, Cabayan H (eds.) Strategic Multilayer Assessment Group Whitepaper on Leveraging Neuroscientific and Neurotechnological (NeuroS&T) Developments with Focus on Influence and Deterrence in a Networked World. Strategic Multilayer Assessment Group, Joint Staff, J3, DDGO, OSD/ASD (R&E)/RSD/RRTO. [Governmental White Paper]
2. Steinmann M, Shuster J, Matei S, Collmann J, Tractenberg RE, Dolling L, Morgan G, Richardson D, Russell A. (2015). Privacy in the Infosphere: Developing ethical guidelines for managing Big Data in Research. White paper ahead of NSF-funded conference, Washington, DC April 2015.

#### **Chapters**

1. Tractenberg RE, FitzGerald KT, Giordano J. (2014). Engaging Neuroethical Issues Generated by the Use of Neurotechnology in National Security and Defense: Toward Process, Methods, and Paradigm. In J. Giordano (Ed). *Neurotechnology in National Security: Practical Considerations, Neuroethical Concerns*. NY/Boca Raton: CRC Press. (Chapter 17).
2. Steinmann M, Shuster J, Collmann J, Matei S, Tractenberg RE, FitzGerald K, Morgan G, Richardson D. (2015). Embedding Privacy and Ethical Values in Big Data Technology. In: Matei, S. A., Russell, M., and Bertino, E (eds.). *Transparency on Social Media - Tools, Methods and Algorithms for Mediating Online Interactions*. New York: Springer. 277-301.
3. Tractenberg RE. (2016-a). Integrating ethical reasoning into preparation for participation to work in/with Big Data through the Stewardship model. In, J. Collmann & S. Matei (Eds)., *Ethical Reasoning in Big Data: An Exploratory Analysis*. New York: Springer. 185-192.
4. Tractenberg RE. (2016-b). Institutionalizing ethical reasoning: integrating the ASA's Ethical Guidelines for Professional Practice into course, program, and curriculum. In, J. Collmann & S. Matei (Eds)., *Ethical Reasoning in Big Data: An Exploratory Analysis*. New York: Springer. 115-139.
5. Tractenberg RE. (2016-c). Creating a culture of ethics in Biomedical Big Data: adapting 'guidelines for professional practice' to promote ethical use and research practice. In, L. Floridi & B Mittelstadt (Eds)., *Ethics of Biomedical Big Data*. London: Springer. 367-393.

### **Proceedings**

1. Tractenberg RE. (2016). Why and How the ASA Ethical Guidelines should be integrated into every quantitative course. *Proceedings of the 2016 Joint Statistical Meetings*, Chicago, IL. Pp. 517-535.
2. Gunaratna N, Tractenberg RE\*. (2016). Ethical Reasoning for consulting with the 2016 Revised ASA Ethical Guidelines for Statistical Practice. *Proceedings of the 2016 Joint Statistical Meetings*, Chicago, IL. Pp. 3763-3787.
3. Tractenberg RE & FitzGerald KT. (2015). Responsibility in the conduct of Quantitative Sciences: Preparing future practitioners and certifying professionals. (presented at 2014 Joint Statistical Meetings, Boston, MA). *Proceedings of the 2015 Joint Statistical Meetings*, Seattle, WA. Pp. 4296-4309.
4. Tractenberg, RE. (2013). Ethical Reasoning for Quantitative Scientists: A Mastery Rubric for Developmental Trajectories, Professional Identity, and Portfolios that Document Both. *Proceedings of the 2013 Joint Statistical Meetings*, Montreal, Quebec, Canada. Pp. 3959-3973.

### **Presentations (national and international meetings)**

1. Tractenberg, RE. Invited Speaker: Decision-making vs. factual knowledge for the responsible conduct of research/responsible research & innovation. PhD Research Ethics Seminar, Universitat Politècnica de Catalunya. Barcelona, Spain.
2. March, 2016.

3. Tractenberg RE. Invited Speaker. Lessons from the Revised Ethical Guidelines for Statistical Practice of the American Statistical Association. Association for Practical and Professional Ethics 25th Annual Conference, Reston, VA. February 2016
4. Tractenberg, RE. Invited speaker: Train the Trainer: growing ethics training capability/opportunity.
5. ELIXIR/EXCELERATE Train the Trainer Workshop, Hinxton, UK January 2016
6. Tractenberg RE. Invited speaker: Professional ethics can promote professional identity development throughout the research curriculum. Victor Babes University of Pharmacy and Medicine, Faculty of Informatics and Biostatistics, Timsoara, Romania. January 2016.
7. Tractenberg, RE. Invited panelist: Symposium on Ethics in teaching and practicing statistics. "How formal training in the ASA Ethical Guidelines for Professional Practice can support collegiality, collaboration, and ethical science." International Statistical Institute (ISI) World Statistics Conference, Rio de Janeiro, Brazil. (Session IPS061) July, 2015.
8. Tractenberg, RE. Invited speaker: Program on Practical ethics: How academia, government, and industry can implement standards of practice for quantitative sciences. "Challenges and opportunities in teaching standards of the professional practice of quantitative science to graduate students in and outside of statistics programs." Joint Statistical Meetings 2015: Seattle, WA. (Session 211121). September, 2015.
9. Tractenberg, RE. Invited discussant: Session on Professionalism, Professional Identity, and Training for Ethical Statistical Practice. Joint Statistical Meetings 2015: Seattle, WA. (Session 211063). September, 2015.
10. Tractenberg RE, FitzGerald KT. Invited Speaker. Reconceptualizing instruction in the responsible conduct of research. Jesuit Schools of Medicine National Conference, Washington, DC. February, 2013.

#### **Posters (national and international meetings)**

1. Tractenberg RE. (2016, March). Professionalism and responsibility in the ELIXIR initiative through a focus on reasoning & decision making. ELIXIR All Hands Meeting, Barcelona, Spain. (Poster # 8).
2. Tractenberg RE. (2015, November). On being a (Big Data) scientist: Professionalism and responsibility in the BD2K Training Coordinating Center. Big Data to Knowledge (BD2K) Initiative All Hands Meeting, NIH Campus, Bethesda, MD. (Poster # 12).
3. Tractenberg, RE\* & FitzGerald KT. (2014, August). Responsibility in the conduct of Quantitative Sciences: Preparing future practitioners and certifying professionals. Joint Statistical Meetings, Boston, MA. (Abstract # 313307)
4. Tractenberg, RE. (2013, August). Ethical reasoning for quantitative scientists: portfolios and developmental trajectories. Joint Statistical Meetings, Montreal, Quebec, Canada. (Abstract # 310084)
5. Tractenberg RE & FitzGerald KT. (2013, May). A multidimensional and dynamic ethics education paradigm spanning the scientist's career. Association for Psychological Science 25th annual convention, Washington, DC.

Institut für Informatik Georges-Köhler-Allee 079 79110 Freiburg

**Object:** Support letter for NSF 2026

To Review Committee

If the proposal submitted by Jason Williams entitled NSF 2026 (“What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century”) is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.



Bérénice Batut

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Freiburg, 10.03.2020



University of Pittsburgh



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**Samuel S. Donovan**

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March 6, 2020

To Review Committee:

If the proposal submitted by Jason Williams entitled NSF 2026: What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

Sincerely,

Dr. Samuel S. Donovan  
Lecturer / PI QUBES  
Department of Biological Science  
University of Pittsburgh



To whom it may concern

Reference: ELIX/CvG/2020.021  
Date: 12-03-2020  
Subject: Support letter

Dear Review Committee

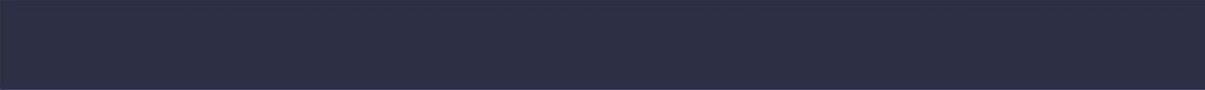
If the proposal submitted by Jason Williams entitled NSF 2026: What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

With kind regards,

Dr. Celia W.G. van Gelder

Programme Manager DTL Learning  
Training Coordinator ELIXIR-NL  
Co-lead ELIXIR Training Platform  
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March 13, 2020

To Review Committee:

If the proposal submitted by Jason Williams entitled NSF 2026: What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

Sincerely,



Dr. Kari L. Jordan  
Acting Executive Director  
The Carpentries



Cold Spring Harbor Laboratory  
MEETINGS & COURSES PROGRAM

March 12<sup>th</sup>, 2020

1 Bungtown Road, P.O. Box 100  
Cold Spring Harbor NY 11724-2213  
<http://meetings.cshl.edu>

To the Review Committee:

If the proposal submitted by Jason Williams entitled *NSF 2026: What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century* is selected for funding by the NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment, and Other Resources section of the proposal.

Sincerely,

Charla Lambert, Ph.D.  
Outreach, Training, & Evaluation Manager, CSHL Meetings & Courses Program  
Diversity, Equity, & Inclusion Officer, Cold Spring Harbor Laboratory  
Phone: 516-367-5058  
Email: [clambert@cshl.edu](mailto:clambert@cshl.edu)



March 11, 2020

To Review Committee:

If the proposal submitted by Jason Williams entitled NSF 2026: What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

A handwritten signature in dark teal ink, reading "Teresa Mourad". The signature is written in a cursive style with a large, flowing "T" and "M".

Teresa Mourad  
Director, Education and Diversity Programs  
Ecological Society of America



Tracy K. Teal, PhD  
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Jason Williams  
Assistant Director, External Collaborations: DNALC  
Lead - Education, Outreach, Training: CyVerse  
DNA Learning Center  
Cold Spring Harbor Laboratory

March 6, 2020

To Review Committee:

If the proposal submitted by Jason Williams entitled "NSF 2026: What Works in Workshops – Evolving Short-format Training to Serve Life Sciences STEM Professionals in the 21st Century" is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment and Other Resources section of the proposal.

Sincerely,

A handwritten signature in black ink that reads "Tracy K. Teal".

Dr. Tracy K. Teal  
Executive Director  
Dryad