Lessons learned in building a sustainable and meaningful cooperative outreach program

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Abstract

Introduction

In the United States there is a growing sentiment that scientists conducting primary research with public funding should also be directly engaged in science education through outreach to the community and public schools (NSF 1999, Leschner 2007; Whitmer et al. 2010, Alberts 2013). These perceptions fueled by public opinions that public school K–12 education has failed to adequately prepare students in science literacy (NRC 2007, Feinstein et al. 2013, Mervis 2013, NAC 2016, Sharon and Baram-Tsabari 2020). With little doubt these concerns have grown exponentially with the onset of remote and hybrid educational approaches launched nationwide with the COVID-19 pandemic (Bozkurt et al. 2020, Maqableh and Alia 2020, Toquero 2021).

Research faculty at colleges and universities tend to support the principles of the implementation of broader impact goals in grant funding (Sarewitz 2011), however, the requirements are ambiguous in criteria and the lack of guidance therein surely has left many researchers unprepared (Kamenetzky 2013; Halland, 2019). A now defunded program, the National Science Foundation's (NSF) own Graduate K–12 (GK–12) Program was highly successful in its original goals of enhancing graduate student professional development. At the time this program was the only NSF program that actually embedded scientists in local communities,

predominantly public K-12 schools, as such had allowed young graduate students in STEM fields to forge lasting partnerships within public school systems, informal science centers and across discipline with other GK-12 fellows (Boone and Marsteller 2011, Adams et al 2016; Adams 2020). Despite this program's successes, the announcement to terminate the program was made in 2011 (Mervis 2011). Ufnar et al. (2012) made a call to former participants in this program to disseminate their findings, propose sustainable models to be adopted by other universities and to determine whether there is a place for a program similar to the GK–12 on university campuses, and if so, what the model looks like and what the requirements are for sustainability.

Herein, the authors seek to share their experience, successes, and hurdles in building a sustainable, and meaningful outreach program at their current institution. One author is a former NSF GK-12 Fellow and Association of Science and Technology Center (ASTC) docent and informal educator, the other a professionally licensed and former fulltime middle school science teacher, both are active Clinical Assistant Professors and researchers in their disciplines. This piece is a commentary based on the recent experience of these uniquely qualified geoscience educators at The University of Buffalo across their interrelated departments in forging a collaborative outreach program. While this paper contains no formal studies, in it we discuss the background and the experience in the formation and implementation of the EarthEd Institute, a local outreach program aimed at reaching underserved children in the Buffalo-Niagara area. This piece is being shared with the hope that other such programs may be formed, possibly learning from and improving on the experiences shared here.

Overarching Outreach Goals, Struggles, & Solutions

Constructing the Main Goals, Aspects & Desired Outcomes

The departments of Geology (GLY) and Environment & Sustainability (EVS) at the University at Buffalo, both departments are closely related and several faculty members holding joint appointments in each, recognized a deficiency in the departments' ability to continuously engage and host outreach events. The groups felt that the departments could and should do more for our local education system. Thus, an ad-hoc committee that included both tenure-track and clinical faculty was formed to begin the journey of transforming the idea into reality. This committee quickly decided on the outreach program's basic overarching goals that included 'must haves' and 'must not include' to best suit the two departments' abilities and needs (Table 1). A general consensus was founded between the two departments and planning for implementation soon followed.

Table 1: Preliminary overarching goals for outreach program across departments.

Goals	Mode of Delivery

Create a program that has high impact Diversity, Equity, & Inclusion (DEI) components for urban and rural underserved public schools	Low to No cost participation for educators from underserved districts
Involve real research from our tenure-track faculty; demystify STEM	Enlist faculty present their research in the form of a lecture to this novice audience
Promote experiential learning components that align to state & federal standards	Create hands-on learning experiences for educators that can be scaled up or down in their classroom; supply materials as needed to the classrooms based on best current practice as presented by scientists earlier in the program.
Emphasize relevancy of science in our region	include local citizen science & research opportunities for educators & students
Establish & foster long-term relationships with local educators & their students; create opportunities & engagement in our communities	Establish a year-long outreach component to have scientists and/or graduate students available for support for participating educators in their classrooms

Conceptual Frameworks for University-led STEM Outreach

For developing the framework of a university-led outreach program, is it often stated that there are two opposing scenarios to be considered as framing the boundaries of outreach operations within universities (Eilam et al., 2016); top-down and bottom-up scenarios. The two extremes hypothetically embodying a continuum which allows for a range of operational modes within each. Top-down is a scenario in which the university governance develops a policy and management systems for performing STEM outreach programs. Top-down approaches are funded from their launch and are frequently longer-lived programs than bottom-up approaches (Eilam et al., 2016).

The bottom-up approach is developed spontaneously, and centralized initiatives and policies are absent as a guiding directive but evolve in place during outreach to direct these operations (Eilam et al., 2016) with limited links between the outreach programs and the central university management systems. These programs evolve spontaneously through the initiatives of individual academics or other staff. Once they are up and running the discrete faculties would attempt to support them within their limited capacity, as add-ons (Eilam et al., 2016). Often, the programs operate under the university governance's 'radar', unregistered, and known only to those who are directly involved with them. In this scenario, the main challenge that the programs face is obtaining legitimacy within the organization; supply of space, facilities, administration, and other services would be based

mostly on goodwill and availability of the individual and department-level support. Such constraints are a challenge for small departments or individuals wishing to start up an outreach program and often littered with start-stop issues (Eilam et al., 2016), at least until internal legitimacy is achieved and continuous support is granted from the institution.

Having little idea on how to initiate press, advertisement, and foundational funding, we originally sought out help from our college administration. While the university is an R1 institution the direction at which the administration was immediately taking the concepts and the costs at which they projected for running the outreach program well exceeded what we thought was ideal for our primary goal of creating a low to no cost and high impact program meant to serve underserved rural and urban communities. We abandoned our relationship with university administrators and as such the bottom-up approach was the basis in which our program began but knowing how difficult this route would be we began to reach out to other potential support systems as collaborators and first years' support systems. Thus, we inadvertently created a third approach, one that is collaborative and bridges the needs and goals of the community, the academics, and public informal education centers.

Informal Science Centers in Outreach Collaborations

The requirements set forth by funding agencies for outreach components are broad and deriving a sound and succinct program is often laborious for researchers. Primarily, establishing relationships with public schools and teachers can be time consuming. Thus, having had experience working in and with informal science centers, we were aware of the resources that they possessed and wanted to integrate our regions informal science centers into the EarthEd Institute. Forging relationships with informal science centers is a great starting point for those with little time or resources at hand. Science centers (ASTC centers, natural history museums, nature centers, etc.) often provide community education programs that welcome researchers to participate in and assist, however, many professional development series and paid programming are a source of income for non-profits. As such, the long-term impacts of researcher contributions may fall short of the broader impacts intended. Non-profit informal science centers' make great collaborators, many are ready and willing to assist with outreach program implementation but should not be considered the solution to the broader impact aspect of research funding but a starting point.

We wanted our participating educators to be familiarized with informal science centers in and around the Buffalo-Niagara Metro Area and understand that EarthEd Institute workshop activities (hands-on lesson plans) could augmented with field trips where possible. Many institutions have classroom-supportive activities on hand and could be utilized for instruction on these sites without additional work on the end of the teachers. Given the breadth of research the two departments are involved in academically, we already had a list of friends in the field ready and willing to help us out. We formed formal collaborations with several local institutions (e.g., nature preserves, Audubon societies, remediation non-profits, etc.) and incorporated visits to these facilities in our workshop planning. These collaborations go further than the week-long workshop, both the informal science centers'

now advocate for our outreach program and we for theirs. This creates a new source of well-respected advertisement for both the university outreach program and these non-profit science centers.

Funding Limitations & Pooling Resources

While research funding may supply generous funds to individuals and groups, combining resources within a whole department or across departments under an outreach program umbrella allows for each dollar to go further. We found that a type of united front approach to funding allowed for our desired broader impact goals to go further, while minimizing researcher time and maximizing effort. In addition, pooled resources make a better, more cohesive program, and the established reputation of an annual program ensures more participation from the community and less time advertising. Further, early career researchers collaborating with outreach coordinators were able to participate with little to no funding given the pooling of resources from senior faculty. This allowed each faculty participant to form their own meaningful approach to outreach within their immediate community.

At the launch of the EarthEd Institute workshop series in July of 2021, we had not yet received direct funding for our outreach program. Research grants listing our institute as a route for their broader impact and outreach were in review. Thus, we were set to launch without funds. Through the generosity of an emeritus faculty member of the Department of Geology at UB, were we granted $2000USD to cover the costs of the program in its inaugural year. As veteran educators of both rural and urban underserved communities, we were able to truly test our "science on a shoe-string" skill in this launch year. In example, where a lesson plan called for 10 sediment corers, we knew that purchasing 10 corers at a minimum of $250USD each was not going to happen. In lieu of such a purchase, we were able to construct nearly identical devices through raw materials purchasing at local hardware and plumbing stores and constructing the units ourselves, producing 10 sediment corers for $120USD total ($12.00/unit). These same sediment corers are now available to be loaned out to EarthEd participating teachers. We also supplied the sediment corer designs and a list of purchase locations and costs of the materials to EarthEd participants.

Resources for outreach extend far beyond cash flow from grants and research funds, people power and creative thinking are some of the biggest assets a coordinator can tap into for planning. Further, keeping in mind that public schools are often cash strapped, particularly for urban and rural communities, let "science on a shoe-string" become a mantra when delving into workshop planning. Financial accessibility to educators should be central to lesson plans.

Federal & State Education Standards & Outreach Applicability

To understand all the federal, state, and advanced diploma standards and outcomes is a full-time job. Expecting a STEM researcher to know, understand, and be able to implement the standards as they pertain to their research to a novice audience is daunting. Further, as research scientists, we often forget where we started in our

educational journey; foundations and structuring of content is necessary to achieve desired final learning outcomes. While we can navigate training on a scanning electron microscope or population statistics with ease, teaching a novice to read begins with phonics, and without pedogeological training of STEM researchers, much is lost in translation. This coupled with the dynamic and perpetually evolving standards often causes frustration for those truly wishing to make an impact in their community's public education system.

As former k-12 educators we wanted to ensure that our workshop and all of its components were applicable to federal and state learning standards. Serendipitous to our collaborative departments, the authors were well versed in formal and informal education systems and pedagogy prior to their work at the university. Through this experience were able to guide research faculty in their lectures and lessons for K12 educators. While this is not true for most departments in STEM, we strongly suggest forging relationships with any departments of education at your home institution if resources and experience of outreach falls short of your needs.

Drawing an Audience

Many higher educational institutions have resources in-house to connect researchers to local public educators. Some are obvious, such as an Office of Community Relations or an Office of Academic Outreach, other resources are more discreetly available, such as tenured colleagues having established relationships and lists of names through their own outreach programming having built-up over the course of a multi-decade career. These resources are priceless, containing anywhere from 12 to 100 names and contact information. In consideration of diversity, equity, and inclusion (DEI), it was a goal of both participating departments to expand our outreach to underserved communities in the Buffalo-Niagara Metro Area, and >90% of the contacts readily available through prior programing involve individual from predominantly white-affluent schools. Hence, we chose to abandon these resources and lists and seek out schools and educators who had not engaged in outreach with our institution. The sheer number of those schools and educators, particularly within urban centers of Buffalo and Niagara Falls were seemingly endless.

The process of recruitment began in 2018. Gathering contact information on public and charter schools is relatively easy, however, getting in contact with individuals interested in participating in outreach programing or an individual responsible for disseminating opportunities is another story. We tried several approaches: 1) physically printing out and mailing out flyers and letters, 2) attempting to coordinate meetings with heads of schools or showing up with flyers, and 3) email blasts to anyone and everyone who may need or advocate for professional development in STEM (e.g., principals, educational coordinators, teachers).

With direct emails and telephone messages direct to high school principals in 2018, only one responded to the opportunity and took time to meet and discuss our program. Following failed emails and telephone messaging in early 2018, we attempted to make contacts through visiting targeted schools with information in hand, in mid-2018. On most occasions (6 of 10 visits) seemingly well received and spoke with someone in-house about our outreach program, in some rare cases we were all but ignored (2 of 10), or disregarded by front of the house staffing (2 of 10). Ultimately, no administrators, principals, or educators responded to physical

materials left at these schools. In 2019, one of the authors was relocated temporarily, and the outreach program was shelved, no recruiting occurred in this year. In January of 2020, flyers and letters we produced and mailed directly to science educators, this was costly, and rendered 4 responses to 75 packages mailed by early March of 2020. Continued recruitment was abandoned in 2020 due to the global covid-19 pandemic. Our final test to recruit educators began in March of 2021. This was done through email blasts, directly to STEM educators in nearby district high schools, we bypassed all school administrators and principals; of 235 emails sent, 22 educators registered for our inaugural outreach workshop. In consideration of the stresses of the pandemic on educators, we felt that this was a very healthy response for the time. The launch of EarthEd Institute was set for July of 2021.

EarthEd Institute Workshop Overview

The development of lesson plans for workshop themed days centered around the primary goals stated in Table 1. What the themes were and the order that they were executed was largely dictated by the participating faculty availability. Summer is field season for geoscientists and as such many researchers were not in the Buffalo-Niagara Region due to the conflict. Where faculty commitments fell short, the authors committed to lectures and lessons centered around their research and successful K-12 lesson plans (Fig. 1).

ECOLOGY					
	Monday July 12	**Tuesday July 13**	**Wednesday July 14**	**Thursday July 15**	**Friday July 16**
	ECOLOGY	RESTORATION	HYDROLOGY	EVOLUTION	SUSTAINABILITY
9:00	Registration, Pre-Workshop Survey & Ice Breaker: Henshue	Gray to Green: Restoratioin of WNY Communities Henshue	Current Research & Tech	Current Research & Tech	Sustainability projects in schools
10:00	USING ECOLOGY IN THE CLASSROOM Henshue	NYS resources for brownfields and restoration: Radon	Chris Lowry	James Boyle	
10:40	Break	Break	Break	Break	Break
11:00	USING ECOLOGY IN THE CLASSROOM Henshue	Community gardens and outreach:	Citizen Science in the classroom: Lowry	Caminicules/Lizzards	Integration & debriefing
12:00	Lunch	Lunch	Lunch	Lunch	Lunch
13:00	NATURE JOURNALING for ELA: Henshue	Silo City field trip: Grundy VANS	Analytical Data Science in the classroom, AKA: "Don't panic!"	Natural History and morphology for Evolution Education: Geffner VANS	Environmental history in the US: Rome
14:00					
14:40	Break	Break	Break	Break	Break
15:00	Lesson development for Ecology and journaling	Creating a restoration project on your campus	Leaf Packs measuring soil and water biodiversity	Natural History and morphology for Evolution Education: Geffner VANS	
16:00					
16:30	Integration & debriefing	Integration & debriefing	Integration & debriefing	Integration & debriefing	Integration & debriefing

GEOLOGY					
	Monday July 12	Tuesday July 13	Wednesday July 14	Thursday July 15	Friday July 16
	Climate Change & Glaciers	Remote Sensing	Ancient & Modern Geo WNY	Volcanology?	Venus? Mars?
9:00	Registration, Pre-Workshop Survey & Ice Breaker: Meehan	Integrating math/geospacial awareness into curriculum: LINK	Community Scale Earth Science Projects to enhance current curriculum	Current Research & Tech	Current Research Mars & Venus
10:00	Climate Day: Briner and Thomas	'low tech' mapping (SED CORE LOCS): Meehan	Microfossils of WNY & basinal History Implications: Meehan	Experimental Volcanology & GeoHazards: Kolzenburg	NASA Remote Sensing Resources: Gregg
10:40	Break	Break	Break	Break	Break
11:00	Flex Time: LINK	Flex Time: LINK	Flex Time: LINK	Flex Time: LINK	Flex Time: LINK
12:00	Lunch	Lunch	Lunch	Lunch	Lunch
13:00	Ping Pong Isotope activity	Higher Tech Mapping approaches: Csatho and Ivan	Schrieber or Stokes history of Devonian Trilobite beds???	Sonder	Integration of real time STEM resource data into Curriculum
14:00	Construction & Implementation of Shoe-string sediment corer		Penn Dixie Fossil Collection	Springville GeoHazards Field Station	Challenges within Curriculum Discussion
14:40	BREAK	BREAK			BREAK
15:00	Data collection best practices: In the field at UB	Creating a mapping project in your classroom: building on basics throughout the year			Interclassroom & Inter-school Collaborations
16:00					Opportunities in real research for your students
16:30	Integration & debriefing	Integration & debriefing	Integration & debriefing	Integration & debriefing	Debriefing & Post-Workshop Survey

Figure 1: EarthEd Institute workshops series' schedule, Ecology and Geology, as established for summer 2021 launch.


RIVERSIDE
class of
2021
#FIRSTCLASSEVER


Zircon -
sometimes

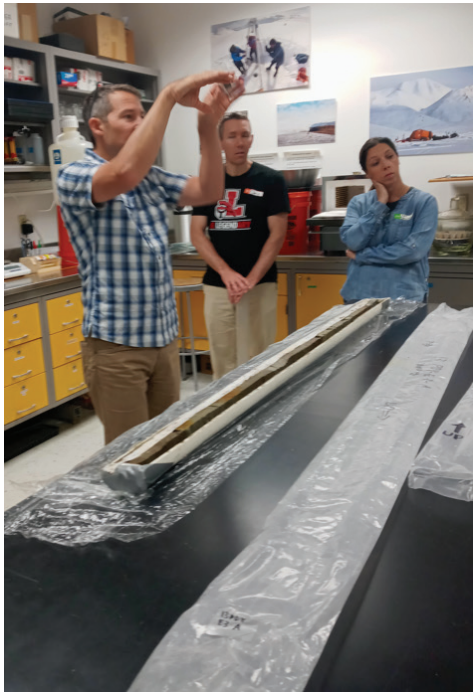

Figure 2: Compilations of images taken during the 2021 EarthEd Institute.

Evaluation & Assessment of Workshops

While the success or failure of an outreach program may be considered to fall upon the coordinator, our endeavor is not exclusive to a single individual, nor is it binary. Organization of the day or week falls upon management of the program, perhaps the primary role of a coordinator, however, some ideas developed and then executed in a workshop are outside of a coordinator's control. The success of a lecture from a research faculty member, the execution of a lesson plan by themselves or supporting graduate students is rooted in several foundational concepts; relevancy for the K12 students, applicability to standards and curriculum, feasibility in the classroom, and more. To better understand, assess, and grow from successes and failures of workshop programming, we developed our own version of a standard informal workshop evaluation used at the New York Hall of Science (Sylvia Perez NYSCI credit somehow).

UNIVERSITY AT BUFFALO
EARTHED GEOLOGY WORKSHOP SERIES
2021

Please take the time to complete both pages of this evaluation. We will use your responses to improve and modify our presentation and to develop future projects.

Name: (optional): _____ Date: _____

1. What grade levels and subject areas do you teach?

_____

2. Before this course, how would you classify your knowledge of the topics covered in the Geology EarthEd workshop?
_____Extensive _____Good _____Average _____Little _____Very Little

3. Were the workshop series objectives clearly explained today?
_____Extensive _____Good _____Average _____Little _____Very Little

4. Were the workshop objectives met?
_____Extensive _____Good _____Average _____Little _____Very Little

5. Did you consider the level of difficulty of the series to be…?
_____Just Right _____Too Easy _____Too Hard

6. Did the workshops stimulate or maintain your interest in the topics covered?
_____YES! _____Yes _____OK _____No _____NO!

7. Were the instructors informative and helpful in answering questions?
_____YES! _____Yes _____OK _____No _____NO!

8. Were the instructors appropriately prepared for the workshop?
_____YES! _____Yes _____OK _____No _____NO!

9. Please provide an overall rating for the instructors.
_____Very Good _____Good _____OK _____Poor _____ BAD!

10. Do you now know enough on the topics covered to teach a good lesson or implement some of the ideas shared this week?
_____YES! _____Yes _____OK _____No _____NO!

11. Do you feel comfortable with your ability to conduct hands-on science activities in the classroom?
_____YES! _____Yes _____OK _____No _____NO!

14. Were the readings and handouts helpful?
_____YES! _____ Yes _____OK _____No _____NO!

15. Would you like to participate in additional courses, workshops, conferences, lectures, etc. through the EarthEd at the University at Buffalo's Departments of Geology and Environment & Sustainability?
_____YES _____ Yes _____ OK _____No _____NO!

16. Did for today's workshop meet your expectations?
_____ YES! _____ Yes _____ OK _____ No _____ NO!

17. Please provide an overall rating for the workshop series.
_____ Very Good _____ Good _____ OK _____ Poor _____ BAD

Please write an explanation for the following questions.

A. Please describe what you like best about the Earth Ed Workshop Series. What was most valuable for you?

_____

B. Please describe which session was most valuable to you and why.

_____

C. What was least valuable to you and why?

_____

D. Please rate the following sessions on their value to you (one being the least valuable and five being the most valuable).

Session 1: Climate Change and Coring Day with Dr. Elizabeth Thomas, Dr. Jason Briner and graduate students?
1 2 3 4 5
Field trip to Letchworth Woods at UB to collect sediment cores?
1 2 3 4 5
Session 2: Geospatial Concepts and Remote Sensing with simple common technologies with Dr. Beata Csatho and Dr. Ivan Parmuzin?
1 2 3 4 5
Session 3: Microfossils of WNY and regional Basin history with Dr. Kim Meehan?
1 2 3 4 5
Field trip to Penn Dixie with Dr. Holly Schreiber?
1 2 3 4 5

Session 4: Hands-on fluid flow (as related to lava flows) activities with Dr. Stephan Kolzenburg?
1 2 3 4 5
Field trip to the Geohazards Field Station, Springville, with Dr. Ingo Sonder?
1 2 3 4 5
Session 5: Current research and integrating planetary|remote sensing data into the classroom with Tracy Gregg?
1 2 3 4 5

E. How would you rate this comprehensive model of a professional development in an educator series? (One being the least valuable and five being the most valuable)
1 2 3 4 5

F. Please add any comments, observations, or suggestions here.

_____

F. Please add any comments, observations, or suggestions here.

_____

_____

_____

_____

G. What from the Forensic Science Educator Series do you think you will use most in your clas (pedagogy, lessons, materials, etc.)?

_____

_____

_____

_____

_____

H. What topics would you recommend for future educator series?

_____

_____

_____

_____

I. Will you recommend the EarthEd Workshop Series to your colleagues?
_____ YES! _____ Yes _____ Maybe _____No _____ NO!

J. Would you take another workshop series as a professional development with EarthEd and th departments?
_____YES! _____Yes _____Maybe _____No _____NO!

Table 2: Results from whole workshops questions from the 2021 EathEd Institute Evaluations. Scores are displayed in both number of educators (N) who voluntarily participated in the evaluations and the corresponding percentages to N.

Evaluation Question	Excellent (N)	%	Good (N)	%	Average (N)	%	<Average (N)	%	Poor (N)	%	Total N

Before this course, how would you classify your knowledge of the topics covered in the Geology EarthEd workshop?	2	16.7	4	33.3	5	41.7	1	8.3			12
Were the workshop series objectives clearly explained today?	4	33.3	6	50.0	1	8.3	1	8.3			12
Were the workshop objectives met?	5	45.5	5	45.5	1	9.1					11
Did you consider the level of difficulty of the series to be…?	12	100.0									12
Did the workshops stimulate or maintain your interest in the topics covered?	10	83.3	2	16.7							12
Were the instructors informative and helpful in answering questions?	11	91.7	1	8.3							12
Were the instructors appropriately prepared for the workshop?	8	66.7	4	33.3							12
Please provide an overall rating for the instructors.	11	91.7	1	8.3							12
Do you now know enough on the topics covered to teach a good lesson or implement some of the ideas shared this week?	5	41.7	7	58.3							12
Do you feel comfortable with your ability to conduct hands-on science activities in the classroom?	5	41.7	7	58.3							12
Were the readings and handouts helpful?	6	50.0	5	41.7	1	8.3					12
Would you like to participate in additional courses, workshops, conferences, lectures, etc. through the EarthEd at the University at Buffalo's Departments of Geology and Environment & Sustainability?	11	91.7	1	8.3							12
Did for today's workshop meet your expectations?	7	63.6	4	36.4							11

Please provide an overall rating for the workshop series	12	100.0									12
How would you rate this compared to other professional development?	8	72.7	3	27.3							11
Will you recommend the EarthEd Workshop Series to your colleagues?	11	91.7	1	8.3							12
Would you consider taking another PD with EarthEd/UB?	12	100.0									12

Table 3: Workshop centered question comments.

Liked best about UBEE/most valuable?

- I loved the hands-on workshops. Most valuable is applications for my classroom (and LAVA!)
- Good variety of presentations and info. Good mix of sitting & exploring
- Seeing science taught in context was extremely valuable to me. I find I can learn things better when I see them happening. I really liked seeing the current research from the faculty and getting ideas on how to incorporate it into my classroom
- After challenges and frustrations of the last academic year, it was refreshing and inspiring to work and learn alongside such dedicated professionals. This workshop has excited me to reconnect with my students
- In-depth and highly practical. Staff knowledge and research is very impressive. Informal structure led to more efficiency
- I enjoyed the different topics and how we thought about/figured out how we would use things in our classrooms
- Collaborating with motivated, knowledgeable teachers and professors on novel lessons and topics. Networking with teachers in similar subjects for ideas and perspectives.
- Collaboration. Fantastic group!
- To collaborate with colleagues on topics. Practice practical classroom strategies that I can use in my classroom on topics

Please describe the session that was most valuable and why?

- Hydrology. Testing water flow. I can easily apply this to my curriculum. I am also able to incorporate citizen science into it.

- I learned an entirely new way to demonstrate/conceptualize grain and H2O flow. I also appreciated a new way to conceptualize greenhouse gases.
- The lava flows, hydrology session, and the sediment core samples were all valuable because that is something I teach. This will definitely be included with my lessons next year.
- The planetary geology session. I teach both earth science and astronomy so it has application in both. I will use google earth mar map when discussing what properties make a planet habitable.
- Restoration ecology - loved the field trips and websites. I plan on using them in my class. - LOVED THE GOATS!
- Hands-on fluid flow - I can do this in my classroom
- I enjoyed all of the sessions and can/will directly apply the resources shared in my science classroom. I am very excited to have my students create their own sediment cores from Cayuga Creek.
- Sediment coring can be used to illustrate abstract earth science concepts.
- I thought the 'food web' activity was great as well as thinking about everything Earth Pope (*sic* Sandy Geffner) shared.
- Helping make connections and future planning

Table 4: Teacher-centered question comments.

Additional comments, observations or suggestions?

- It would be nice to have ongoing support in my classroom after the workshop
- Thank you for being so flexible. I feel like a lot of classes (*sic* professional development classes) are scheduled to the minute. This was so great!
- This workshop was amazing! I loved how flexible it was and how helpful everyone was. I would definitely be interested in attending next year and helping out if needed.
- Liked the Good/Bad/Good at the beginning of the day. Liked the flexible atmosphere
- I appreciate the hard work and planning that went into making this an informative and enjoyable week for us. Thanks so much!
- Overall, it was really great and gave me tons of good ideas! :)
- Thank you for this tremendous opportunity to improve my pedagogy and enthusiasm for teaching. Your work is deeply appreciated!

- These were all great and most applied to the current ES (Earth Science) high school curriculum, Change the topics so I can attend next year.
- I experienced more Ah-has. A positive, nice and relaxed setting compared to the chaos this year. Positive seeing how ideas and activities work with groups.
- Thank you for hosting this workshop! Not only did I learn a ton that I can bring back to my classroom, but this has been by far the best workshop I have taken in my time as a teacher. This is exactly the type of thing I enjoy doing for professional development. This has been such a valuable experience for me. Thank you again!!

Topics for the future?

- Atmospheric science (climate and weather) air pollution, etc.
- Anything rocks related (I <3 rocks) meteorology would be great too!
- it would be great to have a workshop in meteorology of the great lakes and how they (the lakes) influence the weather in WNY
- Mineralogy and meteorology
- Stream ecology (stream macroecology)
- Air, H2O. Soil and land pollution, climate change, global warming, deforestation and logging, increase carbon footprint, genetic modification, oceanography, meteorology, astronomy, minerals and rocks.

Future Plans & Pivoting

Financing

While in 2022 our workshop format will remain unchanged, our desire to expand and include a third workshop series centered around sustainability themes and a greater commitment to in-class outreach and support remains. Though a generous financial contribution from a grant award winner in the Geology Department we are able to float a second and third year for free to all attendees, however, to have a higher enrollment closer to our desired capacity, we must shift gears in funding of consumables and/or seek out additional financial resources. We are currently seeking funds through private and public education grants and given our initial successes have been offered financial assistance through an affiliated group at the university (RENEW program). Corporate charitable giving requests is a resource that is potentially available through university offices and sponsorship commitments through materials donation are being considered.

Throughout the subsequent school year, the authors maintained regular contact with several 2021 EarthEd attendees through invitations to local lectures and field trips, supplied information and contacts to STEM resources and opportunities for the educators and their students. Since the announcement for EarthEd 2022 was given, six veteran teachers have reached out seeking to attend the alternate workshop and 3 of these individuals wish to assist and/or run a workshops lesson. Further, these educators have created a buzz within their communities and new relationships with community activists are being forged. In addition, graduate students who participated with one research group in 2021 have sought out commitments to participate again in 2022 and through their conversations with peers, several additional graduate students within both departments are becoming involved in 2022.

Conclusions

The creation of an outreach program, whether top-down, bottom-up, or collaborative, is a daunting endeavor. While a top-down approach ensures financial support and longevity of an outreach program, college or university level management styles may affect the flow and creativity of individual workshops and freedoms in approaches. The bottom-up and collaborative approach does allow for more workshop creativity and freedom in decision making, however, the upfront workload may be overwhelming for smaller groups or individuals seeking to launch an outreach program. The creation, organizing, and implementation requires a diverse set of skills that need to be addressed prior to jumping into such a project no matter what frame-work style is chosen. We strongly suggest a single individual to spearhead communications and organization such as a project manager or coordinator. The success of our program is largely based in the fact that our two departments' faculty and staff are almost always 'on the same page', in that we rarely have division among our colleagues regarding department goals, policies, and desired outcomes, as such, faculty and staff flexibility and assistance was just as important as coordination and organization.

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