

Geopaths: Year One Evaluation Report¹

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Executive Summary

This report offers a detailed synthesis of data collected during the first year of the *GP-IN: Connecting Opportunities for Research Experiences (CORE)* (“Geopaths”) project, described below. It aims to distill the initial impacts of the project on 1) youths’ skill, knowledge, and career awareness in the geosciences, and 2) geoscience professionals’ professional development and potential for application of equity and inclusion principles to their work in the geosciences.

In the data findings that follow, we see:

- For geoscience professionals (*Community Network of Support* or *CNS*), positive impacts on their understanding of and intention to apply concepts of equity, justice, and inclusion as they relate to their geosciences work with youth and young adults.
- For high school-aged youth, positive impacts on their knowledge, skills, and career awareness related to the geosciences.

This report concludes with strategic recommendations drawn from the data, meant to guide the expansion and refinement of the program elements in the second year of the project. This report underscores the essential contributions of the program to advancing equity and inclusion in STEM educational contexts, highlighting its transformative potential.

Background

The urgent need for trained geoscientists to address pressing societal challenges, such as climate change, natural hazards, and wise use of energy resources, and the concomitant effects of these challenges on communities, is apparent. Despite the critical role diversity of perspective plays in fostering innovative solutions to complex issues, the geosciences remain among the least diverse fields of STEM disciplines. Recent studies highlight a stagnation in the diversification of geoscience PhD recipients, underscoring a persistent gap despite concerted efforts to enhance diversity within the field.

Recognizing this gap, the Science Museum of Minnesota (SMM) initiated the Geopaths project. This two-year project aims to develop and implement holistic strategies to forge more inclusive pathways into the geosciences for historically excluded groups, particularly black, indigenous, or youth of color (BIPOC). By leveraging the museum's unique resources, including the St. Croix Watershed Research Station (SCWRS) and the Kitty Andersen Youth Science Center (KAYSC), the project seeks to create a nurturing ecosystem that promotes geoscience research opportunities and college and career pathways for underrepresented youth.

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Central to the project's strategy is the cultivation of a supportive network that bridges the gap between youth and adult mentors. By engaging youth in meaningful geoscience research relevant to their communities and fostering inclusive practices among adult mentors, the initiative strives to model one way to dismantle barriers that have contributed to an exclusive culture within the geosciences. Through these efforts, the Geopaths project aspires to empower youth, foster their STEM identities, and encourage their pursuit of geosciences as a career path, if desired.

The project is grounded in the philosophy of STEM Justice, which aligns STEM education and practice with social justice principles. By training geoscience professionals in the STEM Justice framework and providing opportunities for them to reflect on their practice and employ these principles, and by equipping youth with this framework as well, the initiative aims to broaden participation in the geosciences and equip youth with the tools and perspectives needed to address systemic inequalities through scientific inquiry.

In its first year (September 2023- August 2024), the Geopaths project trained and/or engaged approximately 35 geoscience professionals and 10 high school-aged youth in educational, field research, and analytic experiences related to a SCWRS project looking at salinization in urban lakes. Appendix 1 details these experiences in greater depth. Participating geoscience professionals were recruited through a regional professional network, and self-selected the aspects of the project they wished to participate in. Youth participants were recruited from the larger KAYSC program at SMM and self-selected into the KAYSC's Environmental Justice (EJ)/Geopaths crew. This report concerns the formative evaluation data collected in the first year of the project to guide the iteration of the program in Year 2 as it expands to include more youth and more opportunities for engagement of geoscience professionals. The evaluation is guided by the following questions:

1. To what extent do youth experience change in geosciences skills and content knowledge over the course of the project?
2. To what extent do youth change in their attitudes towards their potential to enter into geosciences career/educational pathways?
3. To what extent are youth supported towards engaging with the geosciences after the project ends?
4. To what extent have geosciences professionals critically examined their practices and gained awareness of strategies to support youth from a diversity of perspectives, identities, and life experiences?

Methods

There were two distinct groups who participated in the Geopaths evaluation: 1) Community Network of Support (CNS) members, who are professionals working in the geosciences in non-profit, industry, higher education, and field research contexts; and 2) high school-aged youth participating in the EJ crew. Evaluative methods used for the CNS included a pre-project survey

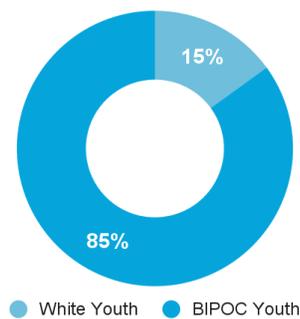
asking about their previous experience in applying social justice principles to their work in STEM and in working with youth underrepresented in STEM fields, as well as a post STEM-Justice training survey, and observational data collected during fieldwork experiences. For youth participants, methods included a pre-/post-program survey documenting youth reflections on their knowledge, skills, dispositions and connections related to STEM and social justice, community-engaged action, career workforce readiness, and several youth development indicators. We also used observational data collected during fieldwork experiences, and group reflections as part of the youth dataset comprising this report. Note that for selected survey data, we are reporting the count of youth who respond, rather than a percent, because the sample size is so small.

Findings

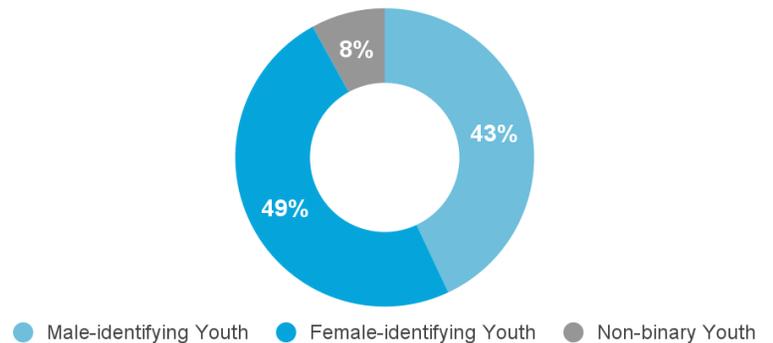
Youth Participants

While we didn't collect demographic information from individual youth, we can provide a demographic snapshot of the KAYSC high school program, collected on an intake form when youth enter the KAYSC program, and say that the youth participating in Geopaths mirror the overall demographics of the KAYSC high school program during this year:

KAYSC High School Youth Race/Ethnicity Demographics (n=55)



KAYSC High School Youth Gender Identity (n=53)



The KAYSC program participants predominantly identify as BIPOC (85%). There are slightly more female-identifying youth (49%) than male-identifying youth (43%), with a small number of youth identifying as non-binary (8%).

Youth Field Experience Observations

Youth had a number of field experiences as part of the Geopaths program (e.g. the University of Minnesota's Continental Scientific Drilling facility (U of M CSD)). During our observations of these experiences we were concerned with 3 impact areas: youth engagement in Paleolimnology, application of geosciences skills and knowledge, and youth building personal and professional networks. Within youth engagement in Paleolimnology we looked specifically at knowledge acquisition and skill development activities (shaded blue in the chart below). For application of geosciences, we looked at how the activities encouraged youth's abilities to apply the geoscience to problems in communities and the development of various communication skills

(shaded yellow). Lastly, noting where youth seemed to build personal and professional networks focused on career/college pathways through their interactions with geoscience professionals was a key impact area (shaded green). The table below lists each field experience and the aspects of the field experience in each of these impact areas. Appendix 1 contains a description of each of these experiences, as well as a brief summary of the observational data.

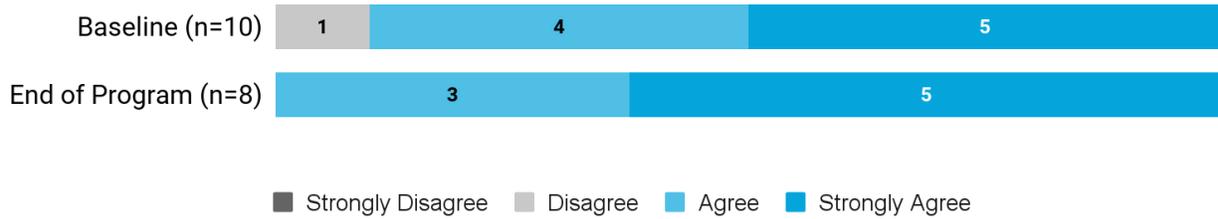
Field Experience	Knowledge Acquisition	Skill Development	Application - Community Issues	Communication of geosciences	College/Career Awareness	Interactions with Professionals
Watershed District	X		X	X	X	X
U of M CSD	X	X			X	X
U of M CSD	X	X	X	X	X	X
Lake Coring	X	X	X	X	X	X
SCWRS Day 1	X	X	X	X	X	X
SCWRS Day 2	X	X	X	X	X	X
SCWRS Day 3	X	X		X	X	X
SCWRS Day 4	X	X	X		X	X
SCWRS Day 5	X	X		X		X

Acquisition of knowledge by youth was observed by evaluators at every field experience, and skill development was present at nearly every one. Application of community issues using the geosciences and also its communication to youth were the least present at $\frac{2}{3}$ of the field experiences. College/career awareness was present at nearly every field experience, while interactions with professionals via the community network of support was observed by evaluators on all programming days.

Youth Reflections and Feedback

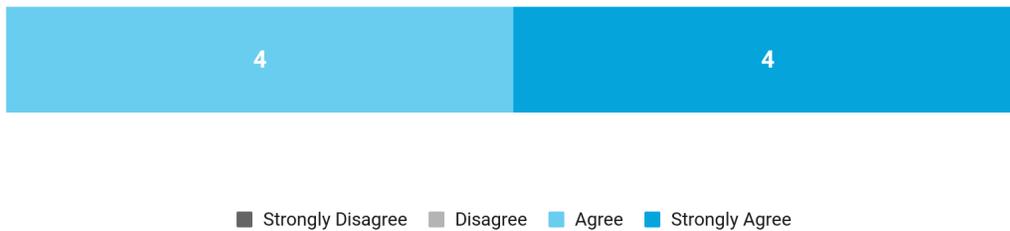
Youth reported slight gains in knowledge (between the beginning and ending of the program year) about how the geosciences can address issues in communities:

I know how STEM can be used to solve problems in communities.



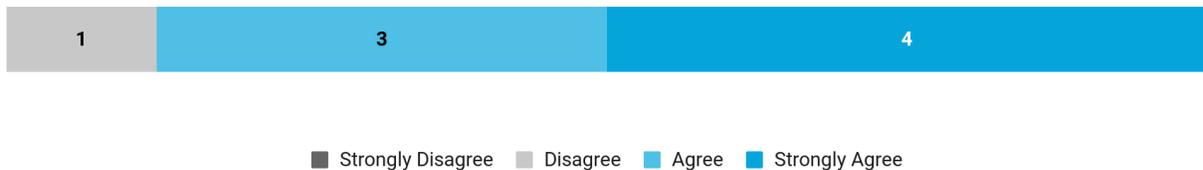
Youth also reported gains in STEM knowledge:

By the end of programming, all EJ youth reported gaining new STEM knowledge



Lastly, a good indicator of the effectiveness of the program in introducing EJ Crew youth to the geosciences, is their interest in continuing to learn about this STEM discipline.

I am interested in learning more about STEM subjects I learned about in the HS program (n=8)



As part of their routine, youth participants and adult staff and CNS members reflected on their experiences at the end of each day during the weeklong program at the SCWRC. Evaluators used this time as an opportunity to gather feedback and stories about the experience.

Personal growth was a recurring theme in the end-of-day reflections. Youth expressed gratitude for moments of personal growth, where they gained confidence, learned to be more open-minded, or listened to new perspectives:

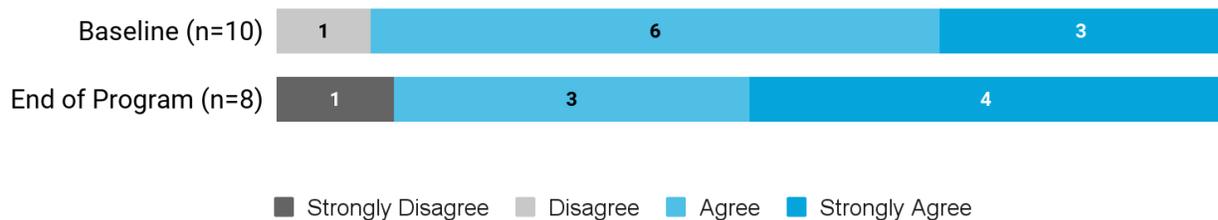
- *For me, one takeaway was to just go into almost everything with an open mind. I don't know, to me, I was like, I wouldn't say opposed to the idea of coming here, but I was nervous for a little bit. I was anxious about it. But probably after the first day, I was like, looking forward to it almost every day, for real.*
- *Okay, so I'm proud of myself for learning and observing everything around me, because I feel like sometimes I get, a lot of the times I get distracted.*

In preparing youth for possible **careers in STEM**, it is important to recognize that STEM can be daunting for youth, and so dismantling the illusion of science via skill development and experience is key. Youth spoke of moments where they felt they had gained knowledge, experience or skills from this unique opportunity to use lab equipment at SCWRC's lab:

- *And then one thing I'm grateful for is the, I don't know, just the opportunity to be able to use the tools in the lab because I don't, it's like I have basic lab training other than this, but I don't know about those like larger like water chemistry specific tools and things, so it's nice to have a space to use those because I don't really know where else I would have access to that.*
- *I'm proud of myself for getting more lab experience. I feel like that's something that's really useful.*

When we asked youth about being able to see themselves in a STEM job or career, we saw some positive shifts in the proportion of youth who strongly agreed to those who agreed:

If I wanted to, I could see myself in a STEM job or career.



Youth expressed gratitude for learning about college/career paths from CNS members that spoke to them throughout the week, and for their openness in willing to connect with the youth outside of the program hours. This affirms that **connecting youth with STEM professionals** in the field offers them unique insights, opportunities and experiences, supporting them in their future education and careers.

- *My biggest takeaway would probably be, like, learning about what this career is like, and also, other careers as well, with the guest speakers that came. I heard a lot of perspectives I don't think I would have heard otherwise, and I've been putting a lot of thought into whether that's like what I want in my life and there's other options too.*
- *And something I'm grateful for is everyone in this room, for real, and all the people who came in and talked to us about their positions and their jobs and their experiences. I learned a lot.*
- *Anyways, I learned from the guest speakers that you don't, I don't know, you can just take classes just to take them. They don't have to be a part of it. I know you can go into college not focused on a major, but I figured to get all your credits by the end, you'd have to do certain classes related to it, and you can just do classes that aren't just 'cause. I didn't know that.*

These reflections are also mirrored in the survey data, where EJ Crew youth reported gains in their networks at the end of the program year:

I have developed a professional network that I can use for my own goals (n=8)



■ Strongly Disagree ■ Disagree ■ Agree ■ Strongly Agree

These same data are collected from KAYSC youth participating in program tracks other than Geopaths, and we noted that the Geopaths participants answered similarly to the other youth in the program, with 62% agreeing and 33% strongly agreeing (n=53) that they developed a professional network they could use for their own goals. This could be because these survey data were collected before a key aspect of the program, the weeklong SCWRS field experience. The project team will continue to monitor and think about how and when we find out about youth’s perceptions of their professional networks and career trajectories in Year 2.

Whether or not they choose a STEM career or reach out to one of the STEM professionals in our Community Network of Support,

All youth reported an increase in their confidence to pursue their career goals because of the program (n=8)



■ Strongly Disagree ■ Disagree ■ Agree ■ Strongly Agree

These data reflect that the program had a strong positive impact on helping youth think about the careers that are available to them and coming to some clarity about what might be a good career path for them.

Community Network of Support (CNS) Participants

The Geopaths CNS participants are a group of geoscience professionals working in non-profit and higher education institutions across Minnesota. Our goals for the CNS were both to connect youth with STEM professionals in order to expand their awareness of geoscience careers and educational pathways and to build the capacity of geoscience professionals to critically examine their practices and gain awareness of strategies to support youth from a diversity of perspectives, identities, and life experiences.

CNS: Pre-participation skill/knowledge, experiences, and support

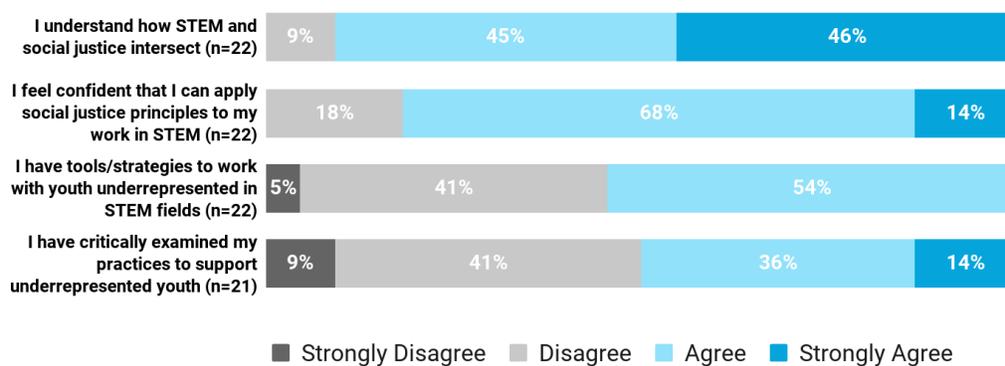
Before beginning work with the project, CNS participants generally described the intersection of social justice and STEM by focusing on the disadvantages faced by underrepresented communities when first entering the STEM field:

- *All people receive access to resources and opportunities, in a way that meets them where they are.*
- *Women, POC, and other underrepresented populations are less likely to go into STEM, partially due to lack of representation.*
- *Intersecting social justice with STEM could mean advances in science are fueled by people with a lived-experience of inequities.*
- *STEM fields have a deep history of contributing to injustice toward marginalized people both intentionally and unintentionally.*

Many CNS members touched on the lack of support STEM provides to the BIPOC communities as well as the harm STEM has caused to underrepresented communities both intentionally and unintentionally.

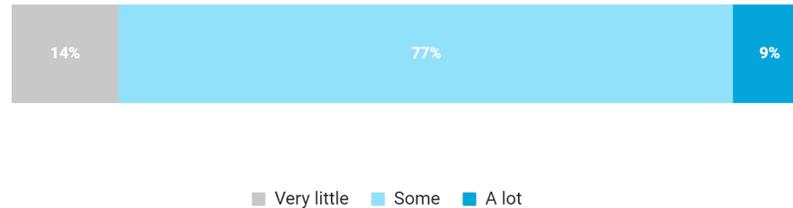
These comments about STEM and social justice reflect the perception of CNS members that they understand the connection between these two ways of seeing the world, though feel less confident about applying that understanding to their work in STEM:

CNS participants reported understanding the principles of STEM and social justice and the confidence to apply it to their work. However, for many, more critical examination of their practices is needed to better support underrepresented youth in STEM fields.



It was clear from the outset that providing space for CNS members to learn and share resources, and critically examine their practices for youth underrepresented in STEM, was needed. Even though:

Most CNS participants reported that they had had "some" or "a lot" of training/support to embed equity and inclusion frameworks into their work (n=22)



Part of the issue seemed to be that there was sometimes misalignment between the intentions and goals of individual CNS members around supporting work with underrepresented youth in STEM fields, and the practices of the organizations they worked in. CNS members provided several examples of institutional practices which highlighted a lack of diversity and organizational support for underrepresented groups in STEM:

- *[My organization] hasn't thought deeply about engaging underrepresented youth in STEM, and thus its practices assume, for example, that all prospective students are interested in and motivated by the same kinds of stories about STEM.*
- *I wouldn't say we don't support them [LGBTQ] as students, but we also don't have any special programs/practices for those students.*
- *Departments with only old, white, men do not offer the representation and mentorship that will attract and make underrepresented people feel drawn in or welcome.*
- *Awarding opportunities based solely on GPA, using high-stakes exams as primary grading tools.*

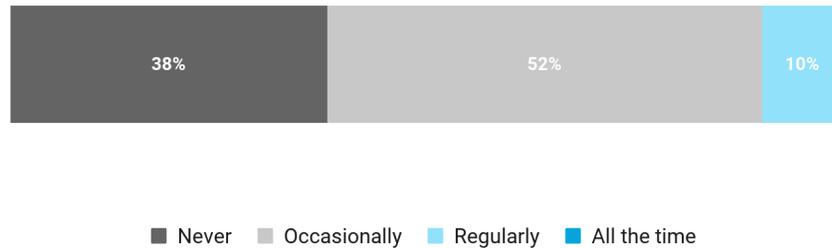
However, CNS members also had some examples of organizational practices they had witnessed which **did** support work with underrepresented youth in STEM, such as programs which decentered whiteness in the work, as well as purposeful engagement and resourcing of youth:

- *Strong education program that interacts with schools and provides in-the-field lessons for youth.*
- *Forming employee resource groups to support professionals from underrepresented backgrounds.*
- *We have prioritized our internal work efforts as well as the work of partner organizations that create connections between BIPOC youth and our field.*
- *Bias awareness and training.*

Many respondents liked to see their organization make efforts to engage youth of all different backgrounds and include programs to support people from underrepresented backgrounds within their communities. Respondents also touched on the effort to decenter whiteness in their workplace by offering bias awareness training and opening the floor to what can be uncomfortable conversations.

Although CNS members had limited experience working with high school-aged youth:

Most CNS participants reported never or only occasionally engaging with youth that are underrepresented in STEM fields in their work within the geosciences (n=21)



it was clear that engaging with high school-aged youth was one of the primary aspects of the project CNS members were looking forward to:

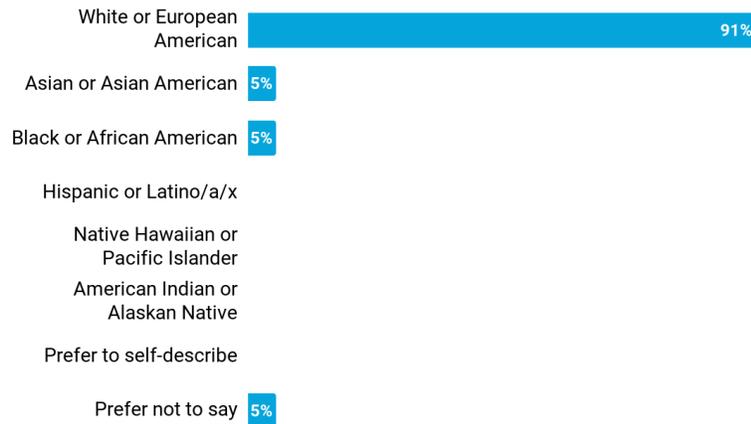
- *Interacting with youth in a community of people supporting this type of learning and engagement.*
- *Diving deeper into understanding equity/inclusion in an applied way; learning from youth, further opening my eyes to privilege.*
- *I'm looking forward to learning practices aimed at making the geoscience experience more rewarding for all of our students at WSU.*
- *I am looking forward to working with young people, cultivating interest, and networking with both youth and STEM professionals in the area.*

CNS members reported excitement for sparking youth interest in the geosciences and STEM, more broadly, and reported being open to learning new social justice practices to integrate into their workplace.

CNS demographic composition

These data reflect the broader need in the geosciences for changed practices and pathways in the work of the geosciences to diversify the field. Our small sample of geoscience professionals who comprise the CNS in this project reflect the limited diversity in terms of demographic characteristics that is representative of the field: members identify predominantly as White or European American. The following tables summarize the CNS demographic composition, beginning with racial/ethnic identities:

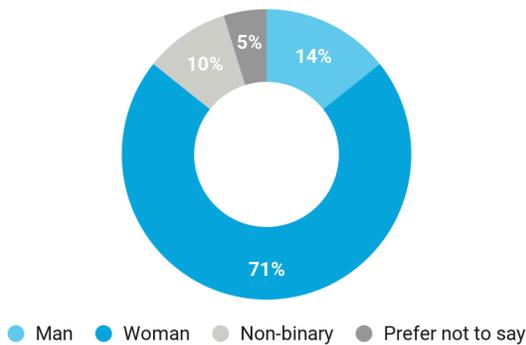
Racial or ethnic identities of CNS members (n=21)



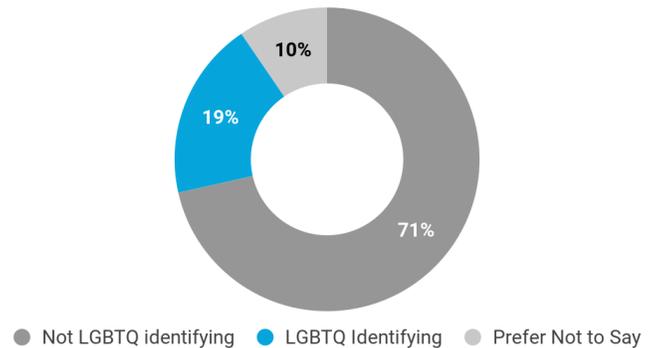
Note: The respondent who identified as Asian or Asian American, specifically noted their ethnic background as Hmong/Chinese.

A substantial majority of the CNS identify as women (71%), and a few members identify as non-binary (10%). The CNS comprises a larger proportion (in comparison to regional demographics) of members who identify as LGBT+. These data underscore the importance of acknowledging and supporting all gender identities and sexual orientations to cultivate an inclusive and more representative community of professionals to serve as mentors for youth:

Gender identities of CNS members (n=21):

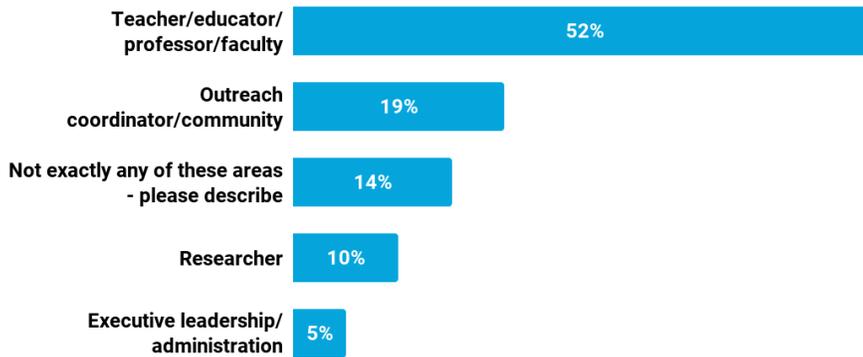


CNS members who identify as LGBT+ (n=21):



The vast majority of CNS members work in educational and community engagement roles, which positions them to employ new practices immediately to better support youth and young adults underrepresented in the geosciences:

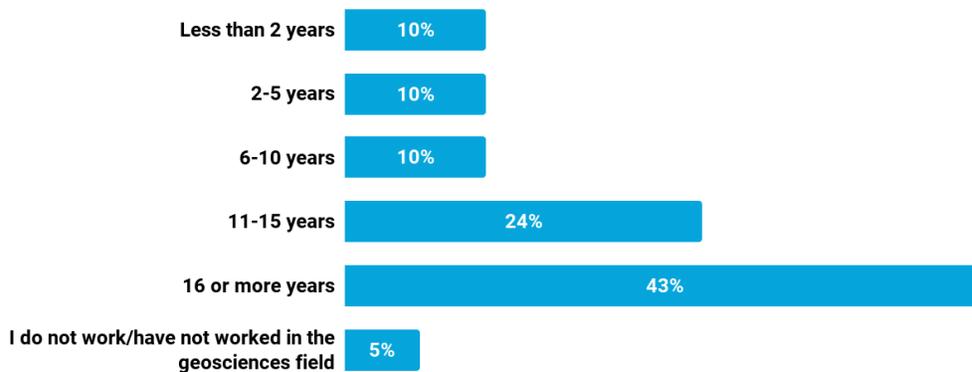
CNS Participant Primary Functional Area in Organization (n=21)



However, almost a third of CNS members have roles that are research-focused, administrative, or don't fit into any of the named categories. The challenge will be identifying whether additional support for how CNS members in these roles can apply the learnings from their participation in the project to their work in the geosciences, particularly if they don't encounter youth and young adults regularly in their daily work.

Lastly, the majority of CNS members have had extensive experience in the geosciences field, with 67% having worked for 11 or more years in a geosciences-related role. Part of our analyses of the impact of this project on geoscience professionals' practice will include looking at data based on years of experience in the field, which may yield some key insights for diversification of the field going forward.

Duration of Experience in Geosciences-Related Field (n=21)



CNS: After training and support in STEM Justice

About two months into the project, we invited CNS members to participate in a three-day STEM Justice training with SMM. This training focuses on supporting professionals to enhance their understanding and application of STEM principles within the framework of social justice. We conducted a post-training survey to get a sense of the impact of the training on new

knowledge/awareness of the intersection of STEM and social justice, as well as to ask demographic questions to provide a snapshot of the CNS members participating in the project. There were 31 CNS members who completed the training and we collected 23 post-training survey responses. While this data doesn't reflect all CNS members, we do believe that it provides support for both the need for and the value of STEM Justice training for geoscience professionals.

Impacts on geoscience professionals' work and workplace contexts:

CNS feedback on several survey items shows that geoscience professionals increased their understanding of STEM Justice as well as how to apply this framework to their work in the geosciences:

96% of CNS participants agreed or strongly agreed that their understanding of the intersection between STEM and social justice improved.

91% felt confident in applying the framework to their professional practice.

91% of CNS participants indicated an intention to apply the framework to their work.

These responses highlight the program's contribution to participants' professional development, fostering understanding of STEM and social justice, confidence in applying complex ideas, and a proactive approach to integrating these concepts into professional settings. One reason that slightly fewer CNS participants indicated an intention to apply the STEM Justice framework to their work was that only 70% of CNS participants thought that the framework was professionally relevant. For some, it may be because their role doesn't include work with youth, or maybe not high school-aged youth (as noted in the demographics section above). For some participants, it may be that the STEM Justice training focused on curricular/programmatic hacks as a means to embed STEM Justice in one's work, and as revealed in the demographic information, nearly a third of participants hold a role that isn't focused on education or community engagement.

At the end of each day of the training, we asked participants for some insights into how they were thinking about the application of the STEM Justice framework. Participants discussed exploring their individual responsibilities in societal change, focusing on self-discovery and justice. They also evidenced an interest in practically applying what they were learning, particularly in addressing oppression and power dynamics in STEM and systemic injustice within organizations. In their words, the training was impactful in these ways by urging consideration of:

- *How characteristics of identity can be considered powerful or marginalizing at different times in our lives, in different groups, or in personal vs. professional circles.*
- *Storytelling as an instrument for expanded learning.*
- *Where to apply what I have been learning and who I can collaborate with.*
- *Doing science is almost always super collaborative, but the stories society tells about STEM are usually a 'lone hero' scientist 'discovering' something.*

- *I have been thinking about the power of convergence science and authentic and collaborative authorship of stories in STEM.*
- *Connecting topics in class to social responsibility.*
- *How can I bring this concept of STEM Justice and evaluating what STEM is to the rest of our staff?*
- *Examining biases in science, making them explicit, and describing how biases can limit STEM and exclude people from both the practice and the benefits of STEM.*

While these represent only a few of the reflections participants had after each day of the STEM Justice training, we see a readiness to discuss practical strategies for identifying and countering oppression in their regular work in the geosciences.

Participant responses also suggest the development of more nuanced understandings of the intersection between social justice and STEM. Before their participation in the program, CNS member responses concerning the relationship between STEM and social justice centered around lack of representation and access to STEM resources and opportunities, as well as attention to how STEM was utilized in perpetrating historical injustices, for communities underrepresented in STEM (see above CNS pre-program data section). After the STEM Justice workshop, CNS described STEM Justice in these ways, and they also described STEM as a tool for addressing structural inequity, emphasizing the importance of integrating social justice practices into STEM fields, particularly in the geosciences, to ensure equitable impact of STEM work on different communities. They also noted that using a justice framework helps reframe scientific and technological processes as essential to providing access to basic rights such as clean water, air, and food.

These post-workshop responses also described the intersection between STEM and social justice as the place where society is currently, and into the future, actively building or changing structures and systems to ensure equal access to STEM benefits and opportunities for all. These responses collectively highlight a more multifaceted understanding of the intersection of social justice and STEM, and may position CNS members to do more transformative work within their organizations.

Impacts on CNS participants' professional networks of support:

While we intended to expand CNS members' awareness and understanding of the intersection between STEM and social justice by offering the STEM Justice workshop, we did not anticipate that CNS members would be highly interested in regularly meeting with other CNS members throughout the project, to reflect on their practice and work with youth and young adults. For some, the interactions with other geoscience professionals were the highlights of the workshop: *The most valuable moments were hearing colleagues' thoughts, so I valued a space to do that.* The following data highlights the quality of participant interactions during the workshop and the support networks that emerged within the program's framework:

87% of CNS participants agreed or strongly agreed that their interactions with other CNS members during the workshop felt like a network of support they could draw on.

In their end-of-training reflections, CNS participants also reported being surprised by how much they enjoyed being in the workshop as a community of learners, noting that they liked:

- *Meeting peers working in this space - It's nice to feel connected;*
- *How comfortable I would feel sharing personal items; and*
- *How open and willing to share everyone was*
- *The diversity of jobs/careers represented in the group; and*
- *Speaking with many different people in the breakout rooms.*

As noted in their pre-program survey data above, CNS members had varying degrees of support for reflecting on their practices concerning, and the institutional supports for, youth underrepresented in the geosciences. Some work environments are not conducive for - and even openly hostile to – open dialogue on examining practices using a DEAI lens; as one CNS participant reflected: *hearing the challenges of doing DEAI from a colleague...how might participating in this workshop be a dangerous workplace action?* It appears that this regional collective of CNS members, from different organizations and different aspects of work in the geosciences, provided an opportunity to be more vulnerable than one might be within the context of their workplace.

Preliminary observational data of CNS members' reflections begin to tell the story of the impact of thinking deeply about how to engage youth from underrepresented groups in the geosciences is having on geosciences professionals. During the field research week at SCWRS, a team of CNS members worked diligently on a curriculum for youth to process and analyze samples, as well as to practice communication about their experiences and results, and hold informal geosciences-specific and geosciences-adjacent career informational sessions. Of the impact of working with other CNS members and seeing the ways in which youth engaged with the material, all CNS members reflected on the importance of the support of their fellow colleagues as they tried to think of curriculum hacks that would be engaging, as well as how much they learned from youths' approaches to the material. As one CNS member remarked:

Sometimes in our work, we get into our research and projects and tunnel vision. So, it's cool to remember all the different ways there are to intersect with science, from the zine making to the art that we talked about... and all of the questions that all of you [youth] asked that brought in your different interests.

These data provide a clear example of the project's impact in both fostering personal professional development and creating a supportive network, suggesting a model that integrates relevant, interdisciplinary content with strategies that promote collaborative engagement, equity and support.

Recommendations

These data highlight the potential of the educational aspects of the program, as designed, to combine professional development with the cultivation of a supportive learning environment for both youth and geoscience professionals.

It appears that the program is having the intended impact on geoscience professionals. However, the opportunities for some of the geoscience professionals in working directly with the high school-aged youth engaged in the *Geopaths* project were limited. Thus, we may not be able to collect data from CPS members that reflects changes to workplaces that might impact high school-aged youth (as many professionals work with young adult youth in higher education settings, if at all). The following recommendations may help to build on the strategies employed in Year 1 to increase the impact on geoscience professionals and help to engage them more closely with youth participants:

- 1) Ask more geosciences professionals to ‘host’ informational meetings/sessions to engage youth participants directly in the contexts of their work;
- 2) Increase the frequency of engagement of the CNS members in reflection with each other about the application of the STEM Justice framework (and/or associated principles) in their work;
- 3) Ask CNS members to compile a list of strategies that might be employed within their specific institutions/organizations to increase engagement of high school-aged youth in skill, knowledge, and/or career-awareness activities; and
- 4) Adjust STEM Justice training to provide space for geoscience professionals not engaged directly with youth/young adults/community members in educational activities to imagine changes to their practices that might impact these groups positively, either directly or indirectly.

These foci could enhance geoscience professionals’ learning experiences and contribute to building a professional community more aware of and responsive to diversity and equity challenges across an array of geosciences contexts.

It appears that the *Geopaths* program is having some of the intended impact on high school-aged youth. The impacts mostly appear to be commensurate with gains across the different program pathways in the KAYSC. It is hard to say conclusively, given such a small sample size, and given the timing of the survey as mentioned above, whether the additional experiences and the thoroughness of the STEM content that youth engaged with in *Geopaths* furthered their STEM interest, identity, and engagement to a greater degree. We will be paying attention to this in Year 2 by more carefully tracking youth’s individual progression and differential experiences across the years of participation in the program. However, the following recommendations may help to build on the strategies employed in Year 1 to maintain and potentially further the impact on youth participants within the *Geopaths* track:

- 1) Encourage more interaction between youth and CNS members to further develop youth’s networks for STEM interest and career exploration;

- 2) De-emphasize the messaging around the goal for the program being more youth entering a geosciences-related career pathway to allow for a more individualized progression as is right for each KAYSC youth, depending on what degree of STEM identity, interest, and engagement they entered the program with;
- 3) Maintain reflection and processing time for youth, as well as arts integration (e.g. zine creation), in order to give youth time to make sense of the program experience in relation to their own interests and goals. The impulse to add more content to increase youth's STEM skill- and knowledge-building in order to generate interest in geosciences-related careers is not supported by the data;
- 4) Work with continuing Geopaths youth in Year 2 to build in more youth agency into the focus and approach of the geosciences-related experiences and lessons, following the KAYSC maxim of 'learners becoming leaders'; and
- 5) Offer more opportunities for youth to practice experience- and activity development for public programs, using the geosciences knowledge and skills they acquired during the program.

Appendix 1

Brief summary of Year 1 field experience observations

Capital Region Watershed

Number of CNS present: 2

Number of KAYSC staff: 4 (excluding E&R staff)

On January 27th, nine youths from the environmental justice track. Accompanied by two members of the research and evaluation team and four KAYSC staff, the group went to the Capital Region Watershed. The trip consisted of an opening ice breaker, small group conversations, an interactive activity, a presentation and then a tour of the facility. During the presentation there was a section of interviews with the staff who couldn't participate on the weekend. The intention was for the staff to be able to share what they do in their position and what led them to their position, however the video was cut short because of technical difficulties. The trip ran from 10:30am - 12:30pm. A CNS participant began with small group conversations to discuss what base knowledge the youth had concerning water. After the small group activity, staff presented an interactive model of a small area to show how litter, sand, chemicals, etc. end up in our water supply when it rains. The presentation consisted of the responsibilities and community engagement of the Capital Region Watershed. To wrap up the visit the youth were led on a tour of the facility and the reasons behind design choices and different functions.

U of M, Continental Scientific Drilling Facility (CSD)

Number of CNS present: 6

Number of KAYSC staff present (excluding E&R staff): 5

On Saturday, Feb. 10th, youth from the environmental justice track along with two research and evaluation staff and three staff members from the Capital Region Watershed, took a trip to the University of Minnesota to visit the CSD. The trip ran from 10a.m. to 2p.m. and was led by a CSD staff member. The youth were able to view lake cores, discuss earth science, the differences in sediment, learn about relevant equipment and ask questions. This experience was originally going to be ice coring but due to unexpected weather conditions it was changed to view lake cores. During the trip the group discussed sediment, land modifications, how coring affects the environment and what educational path would lead to this profession. Youth were able to make observations about the cores presented to them and ask clarifying questions. Participating CNS members encouraged youth to engage and ask questions, promoting healthy banter.

U of M, Continental Scientific Drilling Facility (CSD)

Number of CNS present (excluding E&R staff): 6

Number of KAYSC staff present: 4

On Saturday, March 2nd, six Environmental Justice youth, three KAYSC staff and six CNS adult participants took a trip to Tate Hall on University of Minnesota campus. The facilitation was led by a staff member from the Scientific Drilling Facility. The trip ran from 10:30am to 1:30pm. Unfortunately, time ran out for most of the hands-on portion, so it was cut a few minutes short, but

youth were able to ride back via Ubers to SMM. The youth had the opportunity to use equipment which aided the observation process associated with analyzing cores. A CNS staff member went over the various analysis equipment in the lab, taking time to discuss the importance and usefulness of tracking the salinity of water in the sample cores. Youth were able to use a bladed machine to cut open the sample core under adult supervision. Youth were encouraged to help level the core as part of the preparation process and were also encouraged to make observations of the cores. Afterwards, youth were introduced to the process of documenting the core sample. To finish the day, youth worked in small groups observing the core and documenting their observations such as sediment colors and age of the sample.

Lake McCarrons Coring

Number of CNS present (excluding E&R staff): 5

Number of KAYSC staff present: 2

On May 4th, eight youth from the environmental justice track were accompanied to Lake McCarrons in Roseville by two KAYSC staff, two SMM museum evaluators and five CNS staff. The goal of this trip was for the youth to understand the mechanics of how soil coring is done underneath a lake, what such soil core samples can reveal and the importance of coring to geosciences. The samples taken on this trip will be stored to be analyzed by the youth at a later date. The trip consisted of opening introductions before splitting into two groups and explaining the activities of the day. One group (Group A), which consisted of 4 youths, started on the jonny boat and went out for coring with the coring team which canoed to the center of the lake and anchored down for the day. The other group (group B), which was equal in size, stayed back and worked on sectioning the cores and creating 1cm samples. Around noon, lunch was provided. Group A had the opportunity to watch the facilitators take coring samples and adjust methods to achieve the desired results. Group A was able to take a core sample themselves with supervision. Due to undesirable weather conditions youth were uncomfortable and unprepared for the cold weather on the water. This was noted during the end of day reflection and relayed to the CNS staff.

St. Croix Watershed Research Station (SCWRS)

The St. Croix Watershed Research Center experience ran for an entire week starting on June 24th and running until June 29th.

Day 1

Number of CNS present (excluding KAYSC and E&R staff): 4-6

The first day started with seven EJ youth who arrived slightly later than anticipated. CNS staff started with an icebreaker and a description of the week's activities. The first day entailed a chloride demo, gathering bug specimens from Spring Creek and lastly chlorophyll sampling. During the chloride activity youth first watched a demonstration by a SCWRC staff member and then were allowed to break out to try the activity for themselves. This experiment consisted of pouring water into two small cups, adding two spoonfuls of table salt to one cup and dissolving it, adding food coloring to the cups to differentiate them, and then, using laminated cards, seeing if the waters mixed when the cups were stacked on top of each other. Youth encouraged one

another and learned from each other's mistakes. Youth highlighted how this experiment applied to real life and made other meaningful connections. While finishing the activity other CNS staff arrived and youth took this opportunity to discuss educational and career journeys which prompted a meaningful discussion. After lunch the youth prepared to gather bug specimens from Spring Creek, some were excited while others were hesitant. Some youth were given boots, nets, buckets and paired up to gather specimens with the help of the CNS staff while the other half of youth went to sample chlorophyll. Youth seemed to enjoy the activities until about half an hour in which the temperature went up and bothered the youth. After a successful hunt for specimens KAYSC staff expressed their pride in youth that overcame their hesitancy and took part in the activity. At the end youth, adults and staff came together to reflect on the day.

Day 2

Number of CNS present (excluding KAYSC and E&R staff): 3-5

The second day came with one less youth, there were six EJ youth who participated along with the staff and CNS. The day began with introductions and transitioned into an introduction of concepts. The youth had a hard time understanding the diatom information which caused general confusion amongst the group. Since there were two tests that were to be completed by the youth, they were split into two groups. All tests took place in the lab, so youth were given proper protective equipment. The first test was a chlorophyll test, which required youth to use a pipette as well as a centrifuge. After watching the demo, youth initially struggled to properly use the pipette to transfer water samples. They were then instructed to use the centrifuge to help 'clean' the sample. Youth were then encouraged to document their process and findings in their notebooks and printouts provided by SCWRC staff. At lunchtime, youth were welcomed into the library to chat with three CNS staff, all of which were professors in the geosciences at various Twin Cities colleges. Youth seemed very happy to be given this opportunity and asked them many questions pertaining to their eventual educational pathway. After lunch, youth were split into two groups again, however youth examined diatoms under a microscope after being provided a packet of diatom pictures and names so that each one could be properly identified. Youth showed signs of exhaustion, but attempted to focus and engage. After this activity, all youth, CNS participants and SCWRC staff gathered in the library to reflect on what they had learned that day. Overall, the youth seemed to have a very positive experience, but seemed confused about the complex material they were trying to grasp and tired from a long day of activities.

Day 3

Number of CNS present (excluding KAYSC and E&R staff): 3

The third day of programming had four youth arrive at SCWRC and began with a general overview of the day's activities, as well as the process of analyzing results from a chlorophyll test they would be conducting. Worksheets were provided for youth by SCWRC staff to help them take notes and document their observations/processes. Youth were then split into pairs and were offered opportunities to practice laboratory documentation in the form of properly labeling soil

tubes and were then asked to interpret diatom data. Staff asked youth to ponder how a changing waterfront affects sediment makeup and phosphorus levels. Youth were then given the opportunity to use laboratory chemicals, which meant practicing chemical safety in the form of proper lab attire and precautions. Youth used the centrifuge for their phosphorus experiment and also participated in pipetting and measuring water samples. One youth asked if the model of centrifuge they were using was also used in the medical field for separating plasma. The hands-on portion of the day seemed to really excite and engage the youth. After lunch, the group went into pairs again. One group was asked to examine didymo under the microscope using the water samples they had collected on their first day in the creek. Youth were very vocal during this portion of the day, often expressing wonder and excitement about their findings. Staff explained that didymo were a sign of water pollution and asked youth to interpret what their presence (or lack of) signified about the water quality. At the end of day reflection after this exercise, every youth expressed that the microscope portion was their favorite part of the day.

Day 4

Number of CNS present (excluding KAYSC and E&R staff): 4

On the fourth day of programming, youth (4) arrived late due to traffic. Three KAYSC staff, a member of the research and evaluation team and five SCWRC staff were present alongside the youth. Programming began with a powerpoint presentation inside the library explaining the day's activities and concepts. SCWRC staff gave an overview of the process of conducting acid tests to measure chlorophyll degradation in the lab, as well as tests on prepared samples measuring phosphorus saturation. Worksheets were provided by SCWRC staff for youth to document and follow along. After this, they were again split into pairs. Terms and concepts presented throughout the day included names for chemical and organic compounds, excitation and emission of molecules, units of measurement, properties of acids and wavelengths as a means to seeing absorption through color. Insights in understanding came to youth in the form of understanding the importance of chlorophyll in marine environments, how a chemical reaction helps eliminate interference in a sample by breaking apart organics and isolating phosphorus. And understanding the why of doing mathematical calculations - what the x-axis/y-axis configuration tells you about trends in data. Youth experienced challenges pertaining to steps in the process of prompting chemical reactions and their meaning. Though the work was very challenging (understanding chemistry and math), it was clear that youth felt comfortable interrupting and asking questions to learn how instrumentation worked and how to interpret results. Skill development opportunities were presented in the form of data interpretation, using equipment, critical thinking and precision and measurement. During lunch, youth were overhead talking to CNS members about college, asking them about saving money by going to community college for prerequisites and about the website, "Rate My Professor." By the end of the day, youth reflected on how their interests could be tied to specific STEM fields (marine biology, medicine, anthropology) and that they were curious about mentorships.

Day 5

Number of CNS present (excluding KAYSC and E&R staff): 4

On the last day of the week-long programming at SCWRC, the number of youth increased to six, with three KAYSC staff and five SCWRC staff. The day began for youth with a data analysis project, following step-by-step instructions on how to change code using R (program) on pre-prepared analyses. In the afternoon, a CNS member led youth through a zine workshop and discussion on the intersection of STEM and creativity. Knowledge acquisition opportunities presented themselves in the form of terms and concepts presented via variables for data analysis, coding, the impact of sodium chloride on lake salinity, insights in understanding via the form of understanding Victorian lake history to the present and its impacts, and through challenges in understanding via chemistry and math concepts presented. Skill development opportunities were given to youth in the form of data interpretation, the ability to use laboratory equipment, exercises in critical thinking and in the form of precision and measurement via measuring solutions for testing, measuring dilution and calculating repeatability. Youth had a chance to apply geoscience knowledge to problems when considering the data and what it says about lake composition.

In the afternoon, youth learned about a unique way to communicate about science information or experiences through creating a 'zine, from a professional science communicator, Sophie Wang. Youth saw many examples of zines on a wide array of topics, and with a variety of formats and art styles. Sophie led youth through 3 rounds of zine creation, giving them a chance to create drafts of zines that they could later draw on to create their own science communication tools, or add more detail to the ones they started. The youth clearly enjoyed applying their own personalities and interests to the zines they created to focus in on the details of the field experience week that resonated most deeply with them.