Curriculum Map: Building Open Science Skills for Environmental Justice Movements

ABSTRACT

Institutional shifts toward open science (OS), which emphasizes transparency and collaboration across the entire scientific research lifecycle, present opportunities to develop open science capacity building curricula for environmental justice (EJ) communities. Following a curriculum assessment, a curriculum map was created to inform future development of supplemental resources to the current NASA Transform to Open Science (TOPS) mission Open Science 101 training modules. The curriculum map outlines an EJ specific pathway for TOPS OS101. The proposed curriculum advances equity and builds EJ capacity in open science by identifying and addressing potential knowledge gaps, enhancing relevance for EJ community end users, and promoting inclusivity and accessibility. This curriculum mapping project was conducted as part of a capstone project by a Master of Public Health graduate student at Tulane University School of Public Health and Tropical Medicine. The work products of this capstone project, including the curriculum map, support facilitation of the NASA funded Tulane University supported Advancing Gulf Coast Environmental Justice Leadership & Engagement in Open Science (AGEJLE-OS) project and future development of NASA open science curricula for EJ communities.

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Introduction

Environmental justice (EJ) has roots in the US civil rights movement and is both a field of study and a movement which aims to address health disparities stemming from disproportionate risk of exposure to environmental health hazards and pollution (Ramirez-Andreotta, 2019). Environmental justice can be defined as the meaningful involvement of all people regardless of race, class, or ability in the structural decisions that impact their environmental health including environmental hazards, climate change, and historical injustices resulting in structural or systemic barriers to ensure healthy environments and communities (Environmental Protection Agency, 2024). Open science (OS) is defined by NASA as 'the principle and practice of making research products and processes available to all, while respecting diverse cultures, maintaining security and privacy, and fostering collaborations, reproducibility, and equity' (2024b). Broadly speaking, open science concerns itself with transparency of the scientific processes and aligns itself with increasing equity by engaging diverse participants and cultivating openness to and non-academic knowledge systems including indigenous knowledge, local community knowledge, and marginalized groups (Bertram et al., 2023) (Dos Santos Rocha et al., 2023). Environmental justice and open science intersect with their emphasis on transparency, collaboration, equity, respect for diverse populations, and meaningful engagement of diverse contributors. Building environmental justice community capacity in open science practices to address environmental health issues has the potential to improve trust in the knowledge acquired through the scientific process, promote action leading to structural change, speed scientific discoveries, promote scientific collaboration, and combat misinformation compared to 'closed' scientific processes that are obscured behind paywalls, sequestered by institutional divides, and slowed by the processes of traditional academic publishing.

Despite this potential for environmental justice movements and open science initiatives to inform and support one another, Google Scholar searches for the terms 'open science and environmental justice' and 'environmental health and open science' returns no relevant results. Similarly, a search of PubMed with the terms "Environmental Health"[Mesh]) AND "Community-Based Participatory Research"[Mesh] AND "Open Science" yields zero results. The search term 'open science' does not yield any Mesh results on PubMed. This striking lack of literature illustrates the need for research, development, and innovation at the intersection of environmental justice and open science.

Environmental justice and open science can inform one another to achieve their shared goals of transparency, equity, and inclusive engagement of diverse participants from career researcher to community volunteers. Environmental justice movements offer expertise and best practices in community engagement and pathways for effective academic dialogue with other knowledge systems to promote structural change. For example, a recent critical interpretive synthesis of 232 environmental justice case studies using participatory research methods found that 100% of the 26 cases resulting in structural change began their studies with local knowledge informing the research question and engaged community members in leadership roles (Davis & Ramirez-Andreotta, 2021). Open science introduces principles, technological tools, and skills which have the potential to expedite data analysis, foster collaboration, and lower barriers to entry thus advancing equity initiatives. For example, NASAs equity and environmental justice

program (EEJ) aims to ensure that NASA's earth data can benefit everyone by making NASA sensor data openly available (NASA, 2024c).

Large institutional shifts toward open science practices are evident in recent years with the White House declaring 2023 the Year of Open Science and prominent scientific institutions such as NASA prioritizing open science capacity building through the Transform to Open Science (TOPS) mission (The United States Government, 2024) (NASA, 2024b). Institutional shifts toward different methods cultural communication, such as this shift toward open science practices, offer potential structural opportunities to advocate for social change (Boston et al., 2023). Without established literature available on best practices at the intersection of open science and environmental justice research, open science advocates and educators must look to environmental justice community led priorities and established community based participatory research practices to guide development of open science educational resources for environmental justice community audiences.

Advancing Gulf Coast Environmental Justice Leadership & Engagement in Open Science (AGEJLE-OS) project promotes open science capacity building in environmental justice communities. A comprehensive landscape analysis preceded AGEJLE-OS, in which community members identified priorities for capacity development. Specific priorities include interest in 'manipulating the data for their own investigation and advocacy purposes particularly with online GIS or other visualization tools' and 'an interest in understanding the full spectrum of NASA data and how it is disseminated' (Wright et al., 2023). The Communiversity model of community based participatory research utilized in AGEJLE-OS frames 'community capacity development to serve through the entire scientific process beginning with defining research questions to dissemination and use of results (Wright et al., 2023).' This emphasizes findings of a recent review of community based participatory research methods which underscores the essential nature of including community-specific goals from the beginning of research design (Boston et al., 2023). Capacity building across the entire scientific process also has the potential to combat ongoing systemic bias in funded proposals for research, which continues to disproportionately fund proposals submitted by white male principal investigators (Miner et al., 2023).

This curriculum mapping project supports the AGEJLE-OS project's aim of building environmental justice community capacity in open science to ensure meaningful collaboration at every step of environmental justice research processes using open science practices. A curriculum assessment precedes the curriculum map and accounts for the current open science educational curricula and adjacent resources available through the NASA TOPS pathway. The curriculum map is a starting place to inform future funding opportunities for open science curriculum development for environmental justice community audiences. As we face rapidly changing technological landscapes and new climate realities which exacerbate existing environmental health disparities, this is one small contribution toward working openly together to build equitable and healthy communities and sustainable environmental futures.

Statement of Purpose

The Building Open Science Skills for Environmental Justice Movements curriculum mapping project identifies and addresses potential knowledge gaps in the existing NASA Transform to Open Science mission OS101 curriculum for an audience of environmental justice community engaged researchers. The purpose of this project is to inform future curriculum development to ensure relevance, inclusivity, and accessibility of TOPS OS101 curriculum for a diverse communities of environmental justice (EJ) researchers. This project supports NASA goals to foster equity and environmental justice (EEJ) capacity development projects including the NASA funded Tulane University supported Advancing Gulf Coast Environmental Justice Leadership & Engagement in Open Science (AGEJLE-OS) project.

Graduate student support for the AGEJLE-OS project has included: 1) assessing NASA Transform to Open Science (TOPS) mission TOPS OS101 training modules and other NASA OS resources to identify knowledge gaps and where there is opportunity for supplemental open science educational materials; 2) mapping curricula for EJ facilitators to support EJ community members earning TOPS OS101 badges and effectively utilizing NASA open science resources for EJ research projects; and 3) planning, writing, and submitting proposals for funding seeking to extend open science curricula development and encourage reproducibility of the AGEJLE-OS model for applicability in a broad range of regional EJ contexts.

NASA mission Transform to Open Science (TOPS) is a decade-long strategic commitment beginning in 2022 to engage open science in: 1) lowering barriers to entry for historically excluded communities; 2) understanding NASA data and code used to take advantage of big data collections; 3) collaboration to promote scientific innovation, transparency, and reproducibility. The AGEJLE-OS project aligns with these TOPS goals by building OS capacity which strengthens EJ communities and community members. OS capacity development also promotes novel and high-quality EJ community-led research, bring new insights, understanding, and has potential to advance EJ science (theory, methods, measurement, findings, and evidence-based action).

Aim

The Building Open Science Skills for Environmental Justice Movements curriculum map proposes curriculum development to support building EJ community capacity in open science research skills across the entire scientific process. This aim supports AGEJLE-OS and TOPS goals to promote OS for EEJ capacity building initiatives.

Scope

This curriculum mapping project was initiated as a part of as a part of a capstone project fulfilling graduate degree requirements for Tulane University School of Public Health and Tropical Medicine Master of Public Health student Laura Herrmann. The primary objective of the student's 200-hour practicum experience was to support the Advancing Gulf Coast Environmental Justice Leadership & Engagement in Open Science (AGEJLE-OS) team in their NASA funded research which aims to build environmental justice community capacity in open science. Key objectives of the practicum project were to earn all five NASA TOPS OS101

badges, seek NASA funding to support replication of the AGEJLE-OS model and support future curricula development projects, and create at least two deliverables that support these objectives. Major deliverables included completion and submission of a Future Investigators in NASA Earth and Space Science and Technology (FINESST) Research Opportunities in Space and Earth Sciences (ROSES) program proposal and completion of this curriculum map. Major constraints on the scope of this project included limited access to the EJ communities the project is created in support of because of the nature of remote work, and limited number of hours to complete project due to master's level project graduation requirements and deadlines.

Audience

The target audience for this curriculum map is future open science curriculum developers interested in open science for environmental justice audiences. This includes academic researchers working with environmental justice communities such as the AGEJLE-OS team, NASA TOPS OS101 curriculum developers interested in tailoring their curriculum to environmental justice community audiences, and environmental justice community facilitators who are interested in supplementing the existing TOPS OS101 training modules to improve their relevance and accessibility for their communities and/or organizations.

Objectives

This curriculum mapping project supports the AGEJLE-OS aims to build environmental justice community capacity in open science. The goal of the curriculum map is to provide a foundation to inform future curricula development. Proposed curricula development will supplement the existing TOPS OS101 training curriculum and catalyze development a TOPS OS101 pathway(s) specifically for environmental justice communities, facilitators, researchers, and organizations.

Key Objectives:

- Identify knowledge gaps in OS resources.
- Assess current NASA OS resources for relevance, inclusivity, and accessibility for diverse EJ community researchers.
- Outline plans for development of OS educational content for EJ audiences.

Methods

Curriculum Assessment

A curriculum assessment preceded the development of the curriculum map. The focus on NASA TOPS OS101 curriculum reflects the objective of the AGEJLE-OS project to build community capacity in OS by facilitating EJ community members to seek TOPS OS101 badges. The audience for the curriculum map is future open science for environmental justice curriculum developers and environmental justice community leaders who are facilitators in the AGEJLE-OS trainer-of-trainers model. The following assessment activities of the TOPS OS101 training and other adjacent NASA OS resources available through NASA in support of the TOPS mission were completed between January-July 2024, reflecting thorough assessment the current suite of NASA OS educational tools and resources.

1. Completed the NASA TOPS OS101 training, receiving five module badges.
2. Conducted a brief review of the literature on the intersections of open science, environmental justice movements, and community engaged participatory research with an emphasis on the Communiversity model. Close reading of AGEJLE-OS funding proposal & Working Together: A Landscape Analysis to Inform Practical, Innovative, and Beneficial Use of NASA Earth Science Data to Advance Equity and Environmental Justice in the Gulf South Region.
3. Observed one (1) virtual meeting of the facilitation of TOPS OS101 training materials for EJ community engaged researchers. Attendees included me, Dr. Morrow, Dr. Padgett, and EJ community members who were engaged with the TOPS OS101 training materials.
4. Collaborated directly with PI Dr. Morrow virtually and in person to clarify project goals, EJ community priorities, and receive feedback on work products.
5. Engaged with available NASA OS capacity building resources such as: a) the ROSES proposal pathways (wrote and submitted a NASA FINESST proposal & writing a NASA HPOSS proposal for submission); b) ARSET training modules: *Fundamentals in Remote Sensing,* and *Developing Sustainable Earth Science Applications*; c) ARSET training video: GIS video *Earth Observations for Indigenous-Led Land Management; d)* DEVELOP funding opportunities: explored NASA DEVELOP and SCIENCECORE sites for EJ funding and community capacity building opportunities; e) Nasa Datasets: explored NASA's open datasets for EJ.
6. Engaged with external OS tools & resources for OS community capacity building in OS data analysis and visualization including a) resources to develop skills in programming languages for EJ data analysis, b) AI for assistance in data analysis, and c) spatial visualization tools and geographic information system software. Specific areas of exploration included: Orcid, Zenodo, GitHub, Gemini (AI), Google AI Essentials and Certification (via Coursera), ArcGIS, QGIS, & Basic Code and Python courses (via Codeacademy.com).
7. Assessment according to the criteria of EJ community relevance, inclusivity and accessibility for diverse groups was performed with reflective analysis & SWOT analysis.

Assessment Strategies

While a full curriculum evaluation and summative assessments of the TOPS OS101 training modules for EJ audiences was beyond the scope and resources of the current project, a variety of assessment strategies were used to inform the development of a curriculum map. The goal of this assessment was to identify knowledge gaps in TOPS OS101 training modules that could benefit from the creation of supplemental education and/or facilitation materials to make them more useful in a practical context for environmental justice community audiences. Assessment strategies included: engaging with NASA and adjacent OS curriculums and resources; a brief review of the literature to understand the current context of open science in environmental justice research and what, if any, educational infrastructure may already exist for open science curriculum for EJ audiences; direct collaboration with the PI and observation of PI facilitation of NASA TOPS OS101 content with EJ community members; and reflective analysis & SWOT analysis of the content for EJ audiences. The scope of this assessment is limited to the TOPS OS101 training modules and the open sciences tools and skills referenced in those modules. Three target areas for assessment emerged: 1) relevance for EJ contexts, 2) financial accessibility, 3) inclusivity & accessibility for diverse learners. Guiding questions for each target area were used in a reflective analysis of the EJ end user experience of the existing open science TOPS OS101 curriculum and associated resources.

Table 1. Guiding questions for curriculum assessment & reflective analysis.

Assessment Area	**Relevance for Environmental Justice Community Researchers**	**Financial Accessibility**	**Inclusivity & Accessibility for Diverse Environmental Justice Researchers**
Guiding Questions	Does the curriculum or resource meet the needs of EJ end users? Were the topics relevant to EJ community needs? Are relevant practical use cases and skill development opportunities available? Was the assumed level of background knowledge appropriate?	Is the curriculum or resource financially accessible? Are the tools or educational resources free and available? Is it behind a paywall? Does the curriculum or resource require the use of other technology or infrastructure that will need to be considered to ensure the content is accessible?	Was it presented clearly with multimedia options (visuals & graphics, audio, video, transcripts, closed captions, interactive elements) appropriate for disabled participants (e.g. neurodivergence including dyslexia, auditory and visual impairments)? Is it written using plain language standards?

Findings

There are multiple opportunities for improvement and innovative development of open science curriculum and educational resources for equity & environmental justice audiences in each of the three assessment areas: audience relevance, financial accessibility, and inclusive & accessible content presentation for diverse learners. These opportunities for innovation and development would enhance the capacity building potential of the TOPS OS101 training modules and associated resources for environmental justice end users by making the content more relevant, inclusive, and accessible.

Relevance for Environmental Justice Community Researchers

Practical Applications of Open Science for Environmental Justice

TOPS OS101 does not currently contain adequate examples of practical applications for open science relative to environmental justice research projects or community researchers' needs.

Baseline Knowledge for Current TOPS OS101

The TOPS OS 101 training assumes working knowledge of the entire research process from inception (ideation, proposals, seeking funding) to completion (sharing and publishing results). It also assumes knowledge of qualitative data analysis techniques, familiarity with tools for quantitative data analysis, and basic proficiency with programming languages. This could contribute to inaccessibility or a lack in practical value for audiences without this base knowledge. Much of the content of the TOPS OS101 course was devoted to shifting modes from what may be established practice by career researchers toward open sciences modes of sharing scientific processes and results, again implying an audience of experienced career researchers.

- Assumed base knowledge has the potential to exclude non-academic audience members.
- TOPS OS101 presupposes knowledge and/or experience in the following areas: scientific methods for quantitative research, data management, quantitative data analysis, programming languages, publication of results in academic peer-reviewed journals.
- Opportunity: Improve relevance of TOPS OS101 materials for EJ community researcher audiences.

Financial Accessibility

Much of the TOPS OS101 course content describes open science tools that imply skills and technological resources that may be costly and/or time consuming to acquire. The origins of open science in open-source code and open access software results in an emphasis on pathways of digital sharing that assume reliable access to appropriate technological devices, software, and internet. Successful use of platforms such as GitHub and Jupyter Notebook implies the scientific process is being shared in a programming language. At present, NASA does not offer free tutorials on programming languages. Effective use of large NASA open datasets implies the

ability to analyze the data, and at present that knowledge is assumed in TOPS OS101 though no tutorials are offered. External courses on data analysis may be costly and time consuming.

- Associated resources may require additional skills training and reliable technological infrastructure to be successful.
- Opportunity: Robust development through ScienceCore and HPOSS initiatives to build curricula and educational tools and resources.

Inclusivity & Accessibility for Diverse Environmental Justice Researchers

TOPS OS 101 had few visuals, graphics, meaningfully interactive components, videos, or audio narration. These omissions could make the training less accessible or inaccessible to certain audiences with disabilities, including those with visual impairments and neurodivergences including dyslexia.

- TOPS OS101 training is primary text based, with few visuals, graphics, audio elements, videos, or multimedia components.
- Opportunity: Improve inclusivity and accessibility for diverse researchers in current TOPS OS101 and future iterations of TOPS OS101 and NASA OS resources. Using multimedia presentations, storytelling, and plain language standards who enhance the training.

SWOT Analysis

The curriculum assessment identified strengths, weakness, opportunities, and threats in the TOPS OS101 training modules and associated NASA OS educational resources for audiences of EJ community researchers.

Strengths

- Financial accessibility: TOPS OS101 is a free educational resource which delivers core open science content and can be adapted and extended to a variety of audiences.
- Capacity Building: Completion of TOPS OS101 confers certification badges which can be downloaded or displayed on social media sites such as LinkedIn.

Weaknesses

- Relevance: Baseline knowledge of the scientific research process and practical use cases for EJ researchers.
- Inclusivity & Accessibility for Diverse Audiences: Presentation of materials in primarly written text form could exclude certain audiences.

Opportunities

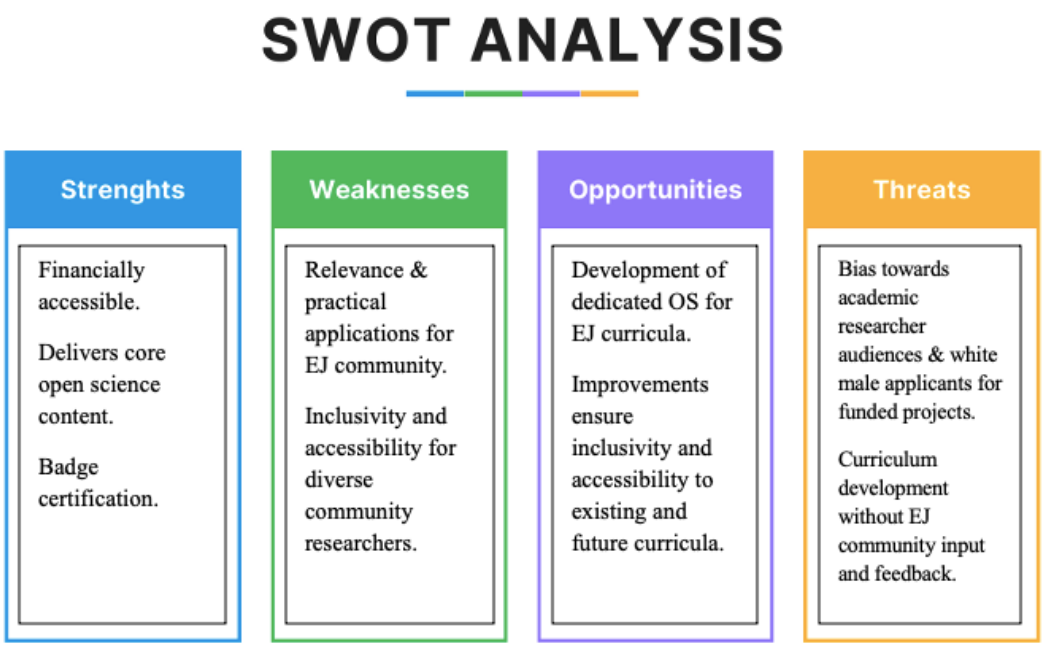
- Curriculum Development: Robust opportunities for curriculum and resource development of OS educational content specifically for EJ audiences.

- Increased Inclusivity & Accessibility: Using multimedia presentations, storytelling, and plain language standards who enhance the training.

Threats

- Bias: Without including EJ communities in development, curriculum developer bias ould introduce unhelpful or harmful elements and could perpetuate inequities such as disproportionate funding opportunities for less diverse (white male) researchers (Miner et al., 2023).

Image 1. SWOT Analysis of TOPS OS101 for EJ Audiences.



Findings Summary

NASA TOPS OS101 is a strong foundation for future curriculum development of OS educational programs and resources, but currently lacks relevance for EJ community researcher audiences and requires improvements for inclusivity and accessibility for diverse researchers in general. Tailored TOPS OS101 content for EJ community audiences is warranted to advance NASA EEJ goals and support the facilitation of the AGEJLE-OS EJ community capacity building in OS goals.

Opportunities for Curriculum Development

The following priorities emerged from the curriculum assessment findings and indicated immediate opportunities for curriculum and resource development to ensure usefulness of NASA TOPS resources for EEJ:

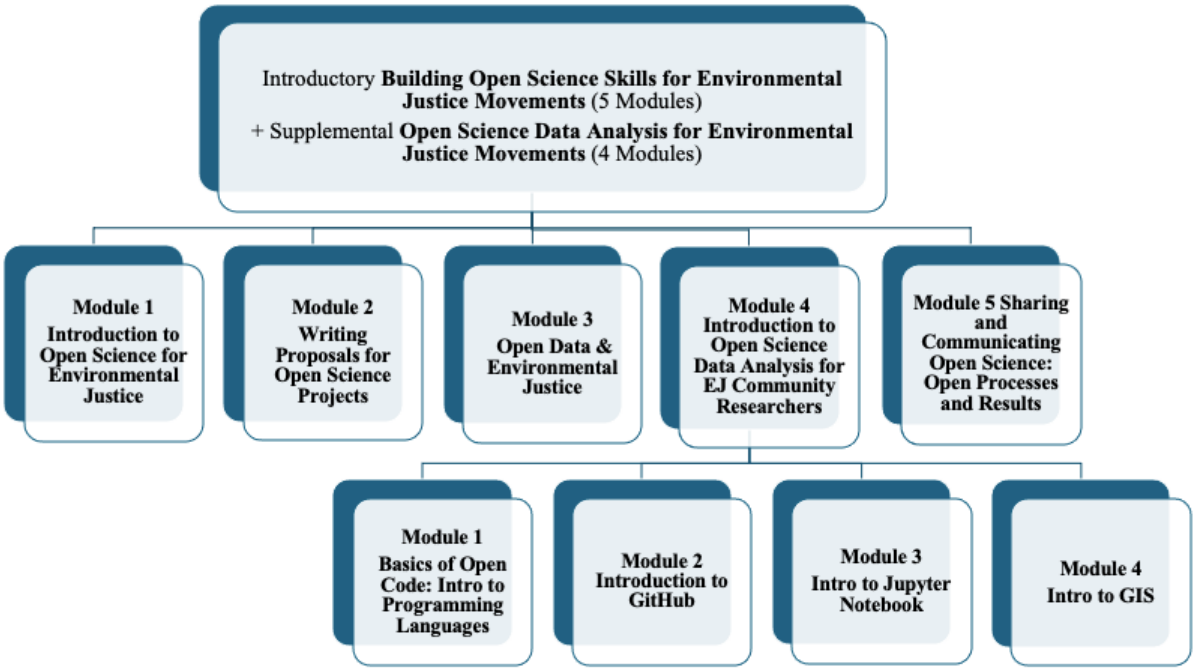
1) Support development of NASA OS resources specific to EEJ concerns and EJ audiences.
2) Plan to engage diverse EJ researcher audiences with the development of accessible and inclusive content. Develop curricula for OS capacity building that is inclusive of:
    - A wide spectrum of ages.
    - Researchers from non-traditional experience backgrounds.
    - Varying levels of, and attitudes toward, formal education.
    - Low-income and underserved communities.
    - Women, BIPOC, and disabled people.
3) Ensure iterative process for future OS for EEJ curriculum development.
    - Plan to collect feedback about the accessibility and usefulness of content.
    - Plan to incorporate feedback to increase accessibility and usefulness.

When assessed for relevance, financial accessibility, and inclusivity & accessibility for EJ audiences, the NASA TOPS OS101 training modules exhibit opportunities for improvement as well as opportunities to develop distinct OS educational pathways for EJ end users. Immediate opportunities for future curriculum development and OS educational resource deliverables are outlined in Table 2 below and include 1) development of a robust five module pathway for environmental justice community researchers within TOPS OS101; 2) development of additional supplementary four module open science data analysis for environmental justice movements pathway; 3) development of a centralized and dedicated NASA webpage which serves as a hub for EJ capacity building opportunities through TOPS and NASA. The curriculum map that follows will focus on the first deliverable, but the others are noted to give comprehensive feedback concerning possible directions for future or concurrent development. Image 2 below is a visual depiction of the proposed relationship between the first and second deliverables.

Table 2. Summary of Development Opportunities for OS for EJ Curricula and Resources

Proposed Curriculum or Resource	*Proposed Scope of Development*	*NASA Funding Opportunities for Development*	*Existing NASA Resources Supporting Development*	*Existing External Resources*
TOPS OS101 For EJ **'Building Open Science Skills for Environmental Justice Movements'**	5 Modules 7 sessions 12 total hrs	ROSES: HPOSS	ARSET TOPS OS101	Deep South Center for Environmental Justice Website
OS Data Analysis for EJ **'Open Science Data Analysis for Environmental Justice Movements'**	4 Modules 10-12 sessions 24 total hrs	DEVELOP ROSES ScienceCore	NASA EJ datasets	Codeacademy.com GitHub, Jupyter Notebook, Google Colab & Gemini (AI), QGIS
Web Hub: Centralized NASA Open Science Resources for EJ Community Researchers	Dedicated web page hosted by NASA to centralize access to OS resources for EJ audiences.	DEVELOP ROSES ScienceCore	DEVELOP, ROSES, TOPS & TOPS OS101, ARSET NASA EJ datasets	N/A

Image 2. Proposed TOPS OS101 Pathway for EJ Audiences Includes Introductory 5 Module Course and Supplementary 4 Module Data Analysis Course.



Curriculum Map

The following curriculum map proposes content that would serve to supplement and enhance the existing TOPS OS101 training to improve relevance for EJ audiences by offering dedicated OS for EEJ learning pathways. The products developed from this curriculum map are envisioned as two distinct TOPS OS101 pathways for environmental justice community engaged researchers. This model follows the precedent of the NASA ARSET *Developing Sustainable Earth Science Applications* training modules which allows users to choose between three distinct pathways for different types of audience engagement with the material. The three pathways available for the ARSET *Developing Sustainable Earth Science Applications* training are 'An Early Career Experience', 'A Community Partner's Journey', and 'An Experienced Researcher's Discovery'. The existing TOPS OS101 training content is most appropriate for experienced researchers. Additional pathways for students, early career scientists, and community engaged researchers are warranted to make the TOPS OS101 content relevant, inclusive, and accessible for other audiences.

The proposed content reflects key concepts covered in the existing five module TOPS OS101 training. Compared to the TOPS OS101 training, the proposed curriculum map reorganizes some of the core OS101content. Restructuring enhances the ability for curriculum developers and facilitators to contextualize open science principles within EJ principles and practical EJ case studies. It also better reflects the chronological flow of the scientific research process. The goal of contextualizing the OS content in this way is to 1) improve relevance of the OS curriculum for EJ community & researchers and 2) encourage EJ community participation EJ research projects by building OS capacity across the entire scientific process.

To ensure there is enough context appropriate for EJ audiences, data analysis is de-emphasized in the introductory 5 module training program. An optional dedicated data analysis training program is added to provide more depth and practical applications for EJ community researchers interested in building capacity in data analysis for EJ research. This model addresses potential issues inherent with the base level of knowledge required for the current TOPS OS101 training and improves relevance for EJ community researchers. The content of the proposed curriculum will be written using plain language and will emphasize practical applications and concrete skill building activities. Visuals, graphics, videos, audio narration, transcripts and closed caption and other accessibility considerations will be central to curriculum development strategies. Incorporation of narrative elements, including guest speakers, case studies, and videos with storytelling components will enhance engagement with the course content. Participants will complete assessment at the end of training modules to earn badges like the current TOPS OS101 certification badge system. Badges can be displayed on various social media profiles including LinkedIn. Opportunities for collecting voluntary feedback from users will be added at the end of each module to ensure an iterative process of curriculum development for ongoing improvements for relevance, inclusivity, and accessibility.

Program Outline: Building Open Science Skills for Environmental Justice Movements

Module 1: Introduction to Open Science for Environmental Justice

Module 1 introduces core concepts and principles of open science to environmental justice community audiences. It reminds the EJ audience of the principles of environmental justice, the Communiversity model of community engaged academic supported research. Participants will relate EJ and Communiversity concepts to open science principles.

Curriculum Development Objective:

- Adapt materials and concepts from existing TOPS OS101 Module 1 for environmental justice community researcher audience.

Learning Objectives:

- Define the core principles of open science, environmental justice, and Communiversity.
- Demonstrate understanding of the principles shared between open science, environmental justice, and Communiversity.
- Apply open science principles to practical environmental justice use case.

Learning Activities:

- Show brief engaging videos which introduce core concepts and principles of open science, environmental justice, and the Communiversity model.
- Summarize how environmental justice & Communiversity principles compare with OS principles.
- Identify environmental justice principles that overlap with open science principles in small groups or in assessment (fill in the blank).

Module 2: Writing Proposals for Open Science Projects

Writing and submitting compelling proposals for research funding is crucial for full articulation of the Communiversity model of community engaged research to ensure meaningful community participation from the inception of a research project. A recent study found that studies were more likely to succeed in achieving structural change policy goals when policy related activities and goals were included in project planning (Davis & Ramirez-Andreotta, 2021). Understanding and implementing open science proposal writing skills, including open science data management plan development, will allow environmental justice community researchers to fully participate in every step of the research design process, which better serves the community (Boston et al., 2023).

Curriculum Development Objective:

- Adapt materials and concepts from existing TOPS OS101 Module 1 for environmental justice community researcher audience.

Learning Objectives:

- List essential components of compelling proposals to secure funding for open science projects environmental justice research projects.
- Name NASA OS funding proposal development opportunities and resources.
- Explain the relevance of open science data management plans to environmental justice research funding proposals.
- Illustrate basic data management plans (DMPs) outlining data collection, storage, and sharing practices following OS principles to support effective proposal writing skills.

Learning Activities:

- Show and define examples of open science data management plans, open data repositories, metadata, PIDs, and DOIs with interactive components and videos.
- Show funding opportunity websites and describe who can apply for different types of funding opportunities.
- Watch video or listen to guest speaker: best practices and tips for writing successful proposals.
- Outline basic open science data management plan components as a small group, or as a part of an interactive assessment (e.g. matching).

Module 3: Open Data & Environmental Justice

Collecting and managing data for environmental justice research utilizing open science principles is an essential skill for community engaged researchers. Building upon the understanding of the relationships between open science, environmental justice, and Communiversity principles established in Module 1 and the open science data management planning skills of Module 2, this module explores the ethics and skills of open science data collection and management for environmental justice research projects.

Curriculum Development Objective:

- Adapt materials and concepts from existing TOPS OS101 Module 3 for environmental justice community researcher audience.

Learning Objectives:

- List ethical considerations in open science data collection & management.
- List ethical considerations based on EJ and Communiversity principles.

- Explain when and why specific types of data may or may not be able be able to be shared openly.
- Demonstrate understanding of data collections & management considerations within EJ case study contexts.

Learning Activities:

- Define OS data collection and management ethical considerations and principles.
- Define EJ and Communiversity data collection and management ethical considerations and principles.
- Video or guest speaker: demonstrate EJ case study with successful data collection and demonstrate ethical considerations that made it successful.
- Summarize relationship between EJ case study and OS data collection and management principles from the example given above. Assessment: short answer.

Module 4: Introduction to Open Science Data Analysis for EJ Community Researchers

Understanding of basic data analysis techniques, skills, tools are required for full participation in the entire research process. Analysis of large data sets is a transferable skill that is a desirable target for community capacity development. Much of the current TOPS OS101 content presupposes some familiarity with the skills and tools of data analysis and from that assumption structures the training modules around shifting those skills towards open science modes of operating by introducing new data analysis tools and platforms. For EJ community engaged researchers from diverse backgrounds, it should not be presumed that there is a data analysis background. Therefore, an introduction to the basics of data analysis is required as an addition to the current TOPS OS101 content.

Curriculum Development Objectives:

- Create new module content that gives a basic introduction to data analysis for environmental justice community researchers.
- Adapt and contextualize materials and concepts from existing TOPS OS101 Modules 2 & 4 for environmental justice community researcher audience.

Learning Objectives:

- Define basic open science data analysis concepts.
- List open-source data analysis tools and resources.
- Relate data analysis concepts to in practical EJ case study contexts.
- Summarize the use of open science data analysis and visualization tools for environmental data to support EJ research projects.

Learning Activities:

- Define data analysis and show examples of OS data analysis and spatial analysis.
- Name and show examples of open-source data analysis tools and resources.
- Outline data analysis tools for practical application in EJ research.
- Demonstrate basic functions of programming languages, GitHub, Jupyter Notebook, and GIS.
- Video or guest speaker sharing an example of practical application for EJ case study.
- Assessment: matching example EJ data sets (broad types) to potential data analysis tools.

Module 5: Sharing and Communicating Open Science: Open Processes and Results

The final module builds skills to effectively communicate research processes and results following open science and EJ principles and utilizing open science tools. The module content will provide more depth about the methods, tools, and importance of sharing research processes and research results openly.

Curriculum Development Objective:

- Adapt materials and concepts from existing TOPS OS101 Module 5 for environmental justice community researcher audience.

Learning Objectives:

- Explain the importance of transparency in sharing processes and results openly.
- Describe the 'reproducibility crisis.'
- List tools for sharing open science processes and results.
- Define digital object identifiers (DOI), persistent identifiers (PID), and licenses.
- Compare alternative routes of communicating processes and results openly to those listed above: websites, videos, blogs, and social media.

Learning Activities:

- Show a short video or briefly describe the reproducibility crisis.
- Show examples OS tools for sharing research processes and results: data repositories, metadata, and open access journals.
- Match digital object identifiers (DOI), persistent identifiers (PID), and licenses to examples of use cases for sharing EJ processes and results openly.
- Illustrate examples of EJ research processes and results shared openly and not-openly using alternative communication routes.

Table 3. Curriculum Map for TOPS OS101 for EJ Audiences Pathway: 'Building Open Science Capacity and Skills for the Environmental Justice Movement' Course (Five Modules)

Module Number & Title	**Module 1** **Introduction to Open Science for Environmental Justice**	**Module 2** **Writing Proposals for Open Science Projects**	**Module 3** **Open Data & Environmental Justice**	**Module 4** **Introduction to Open Science Data Analysis for EJ Community Researchers**	**Module 5** **Sharing and Communicating Open Science: Open Processes and Results**
Module Description	Introduces core concepts and principles of open science, environmental justice, and the Communiversity model of community engaged academic supported research to EJ audiences. Adapts materials and concepts of existing TOPS OS101 Module 1. Length: 2 sessions at ~1.5 hrs each.	Introduces resources to seek funding for EJ research project and describes essential components of the proposal writing process including open science data management plans. Adapts materials and concepts of existing TOPS OS101 Module 1. Length: 2 sessions at ~1.5 hrs each.	Builds upon the foundations of open science, environmental justice, and Communiversity principles to demonstrate understanding of ethical considerations and best practices for collecting and managing data for environmental justice research. Adapts materials and concepts of existing TOPS OS101 Module 3. Length: 1 session at ~2 hrs.	Introduction to basic data analysis for open science environmental justice community researchers. Adapts and contextualizes materials and concepts from TOPS OS101 Modules 2 & 4. Length: 1 session at ~1.5hrs Option to supplement with ***OS Data Analysis Pathway.***	Builds upon previous modules and provides more depth and context for utilizing open communication skills and tools. Adapts and contextualizes materials and concepts from TOPS OS101 Module 5. Length: 1 session at ~1.5 hrs.
Learning Objectives	Define the core principles of open science, environmental justice, and Communiversity. Demonstrate understanding of the principles shared between open science, environmental	List essential components of compelling proposals to secure funding for open science projects environmental justice research projects. Name NASA OS funding	List ethical considerations in open science data collection & management. List ethical considerations based on EJ and Communiversity principles.	Define basic open science data analysis concepts. List open-source data analysis tools and resources. Relate data analysis concepts to in practical EJ	Explain the importance of transparency in sharing processes and results openly. Describe the 'reproducibility crisis.' List tools for sharing open

	justice, and Communiversity. Apply open science principles to practical environmental justice use case.	proposal development opportunities and resources. Explain the relevance of open science data management plans to environmental justice research funding proposals. Illustrate basic data management plans (DMPs) outlining data collection, storage, and sharing practices following OS principles to support effective proposal writing skills.	Explain when and why specific types of data may or may not be able be able to be shared openly. Demonstrate understanding of data collections & management considerations within EJ case study contexts.	case study contexts. Summarize the use of open science data analysis and visualization tools for environmental data to support EJ research projects.	science processes and results. Define digital object identifiers (DOI), persistent identifiers (PID), and licenses. Compare alternative routes of communicating processes and results openly to those listed above: websites, videos, blogs, and social media.
Learning Activities	Show brief engaging videos which introduce core concepts and principles of open science, environmental justice, and the Communiversity model. Summarize how environmental justice & Communiversity principles compare with OS principles. Identify environmental justice principles that overlap with open science	Show and define examples of open science data management plans, open data repositories, metadata, PIDs, and DOIs with interactive components and videos. Show funding opportunity websites and describe who can apply for different types of funding opportunities. Watch video or listen to guest	Define OS data collection and management ethical considerations and principles. Define EJ and Communiversity data collection and management ethical considerations and principles. Video or guest speaker: demonstrate EJ case study with successful data collection and demonstrate ethical considerations	Define data analysis and show examples of OS data analysis and spatial analysis. Name and show examples of open-source data analysis tools and resources. Outline data analysis tools for practical application in EJ research. Demonstrate basic functions of programming languages, GitHub, Jupyter	Show a short video or briefly describe the reproducibility crisis. Show examples OS tools for sharing research processes and results: data repositories, metadata, and open access journals. Match digital object identifiers (DOI), persistent identifiers (PID), and licenses to examples of use cases for sharing EJ processes and results openly.

	principles in small groups or in assessment (fill in the blank).	speaker: best practices and tips for writing successful proposals. Outline basic open science data management plan components as a small group, or as a part of an interactive assessment (e.g. matching).	that made it successful. Summarize relationship between EJ case study and OS data collection and management principles from the example given above. Assessment: short answer.	Notebook, and GIS. Video or guest speaker sharing an example of practical application for EJ case study. Assessment: matching example EJ data sets (broad types) to potential data analysis tools.	Illustrate examples of EJ research processes and results shared openly and not-openly using alternative communication routes.
Evaluation & Certification	TOPS OS101 for EJ Pathway Module 1 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Pathway Module 2 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Pathway Module 3 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Pathway Module 4 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Pathway Module 5 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.

Program Outline: Open Science Data Analysis for Environmental Justice Movements

In addition to the five-module TOPS OS101 for EJ pathway curriculum mapped above, there are the additional opportunities for OS educational curriculum development for EJ audiences to build EJ community capacity in data analysis. One of the major flaws in the existing TOPS OS101 training is presumed baseline working knowledge of and experience working with data analysis techniques and programming languages. For example, sharing the importance of open code resources such as GitHub and Jupyter Notebook assume that those attending the training are familiar with writing code.

Each of these proposed modules provides an entry point for meaningful engagement and skill building with OS data analysis and tools. Topics include 1) programming languages and open-source code, 2) GitHub, 3) Jupyter Notebook, and 4) spatial visualization GIS tools e.g. QGIS. Additionally, each module represents an opportunity for robust multi-session curriculum development and ScienceCore funding opportunities. While the technical expertise and time required to fully map the data analysis curriculum is beyond the scope of the current project, the basic curriculum map outlined here illuminates potential directions which warrant future development.

Module 1: Basics of Open Code: Introduction to Programming Languages

This module conveys basic concepts of programming languages and simple algorithmic functions and introduces the concepts of open code and open source. This module is prerequisite to effective use of open science tools such as GitHub and Jupyter Notebook.

Curriculum Development Objectives:

- Adapt and extend materials and concepts from existing TOPS OS101 Modules 2 & 4 for environmental justice community researcher audience.
- Design new content to build skills in algorithmic thinking and programming languages for EJ community researchers.

Learning objectives:

- List basic concepts of algorithmic thinking common programming languages.
- Name programming languages commonly used for EJ research.
- Name resources for skill development in programming languages
- Relate skills in programming languages to practical EJ case.

Learning activities:

- Define core concepts of programming languages.
- List various programming languages and contextualize their differences regarding use in EJ research.
- Show and engage with interactive learning content to build skills in basic use of programming languages for environmental justice research such as Python and R.

- Select engaging video or guest speaker to relate specific programming skills to practical EJ use case.

Module 2: Introduction to GitHub

Participants will practice basic functions of GitHub including setting up a GitHub page and performing a basic GitHub workflow.

Curriculum Development Objectives:

- Adapt and extend materials and concepts from existing TOPS OS101 Modules 2 & 4 for environmental justice community researcher audience.

Learning objectives:

- Name basic functions of GitHub and define version control.
- Utilize basic functions of GitHub, including creating a profile, a repository, and a readme.
- Apply GitHub to a practical EJ use case.

Learning activities:

- Define essential functions of GitHub and define version control.
- Utilize basic GitHub functions following along with a step-by-step tutorial.
- Make use of an engaging video or select a guest speaker to describe how GitHub skills were applied to a real EJ use case.

Module 3: Introduction to Jupyter Notebook

Participants will gain exposure to basic Jupyter Notebook skills that will allow them to participate in interactive, iterative, and creative development for data analysis and novel EJ research products.

Curriculum Development Objectives:

- Adapt and extend materials and concepts from existing TOPS OS101 Modules 2 & 4 for environmental justice community researcher audience.

Learning objectives:

- Recall essential features of Jupyter Notebook.
- Explain the relationship of collaborative and interactive platforms for OS and EJ.
- Apply basic Jupyter Notebook skills to practical EJ case.

Learning activities:

- Define essential functions of Jupyter Notebook.
- Relate OS and EJ principles to Jupyter Notebook functions.
- Utilize skills essential Jupyter Notebook functions following along with a tutorial to apply basic functions to an EJ research case.

Module 4: Introduction to Geographic Information Systems

The final module will introduce GIS systems and demonstrate how spatial visualization of data can be used for EJ researcher. Knowledge of open-source GIS platforms to collaborate with other researchers. GIS and spatial visualization skills are not currently prominent features of the existing TOPS OS101 training modules. However, GIS is frequently used in EJ, environmental health, and public health research and an EJ community priority for capacity building according the landscape analysis performed prior to the formation of the AGEJLE-OS project (Wright et al., 2023). It should therefore be included in future OS for EEJ curriculum planning.

Curriculum Development Objectives:

- Design new content to build skills in GIS for EJ community researchers.

Learning objectives:

- Define GIS and name relevance for EJ research.
- Show essential functions of GIS for EJ research.
- Illustrate data analysis tools and skills to practical EJ case.

Learning activities:

- Introduce and define essential functions of GIS.
- Relate GIS functions to practical applications for EJ research.
- Demonstrate GIS for EJ practical applications by following step-by-step tutorial: use NASA EJ data set to create a basic map.

Table 4. Curriculum Map for 'Open Science Data Analysis for Environmental Justice Movements' (Four Modules)

Module Number & Title	**Module 1** **Basics of Open Code: Intro to Programming Languages**	**Module 2** **Introduction to GitHub**	**Module 3** **Intro to Jupyter Notebook**	**Module 4** **Introduction to Geographic Information Systems**
Module Description	Understand the essentials of how programming languages and simple algorithmic functions. Open code & open source.	Introduction to GitHub. Set up GitHub page and understand basic GitHub functions and simple open code workflow.	Introduction to Jupyter Notebook for EJ community researchers.	Introduction to GIS systems and spatial visualization of data for EJ community researchers.
Learning Objectives	List basic concepts of algorithmic thinking common programming languages. Name programming languages commonly used for EJ research. Name resources for skill development in programming languages Relate skills in programming languages to practical EJ case.	Name basic functions of GitHub. Utilize basic functions of GitHub, including creating a profile, a repository, and a readme. Apply GitHub to a practical EJ use case.	Recall essential features of Jupyter Notebook. Explain the relationship of collaborative and interactive platforms for OS and EJ. Apply basic Jupyter Notebook skills to practical EJ case.	Define GIS and name relevance for EJ research. Show essential functions of GIS for EJ research. Illustrate data analysis tools and skills to practical EJ case.
Learning Activities	Define core concepts of programming languages. List various programming languages and contextualize their differences regarding use in EJ research. Show and engage with interactive learning content to build skills in basic use of programming	Define essential functions of GitHub. Utilize basic GitHub functions following along with a step-by-step tutorial. Make use of an engaging video or select a guest speaker to describe how GitHub skills were	Define essential functions of Jupyter Notebook. Relate OS and EJ principles to Jupyter Notebook functions. Utilize skills essential Jupyter Notebook functions following along with a tutorial to apply	Introduce and define essential functions of GIS. Relate GIS functions to practical applications for EJ research. Demonstrate GIS for EJ practical applications by following step-by-step tutorial: use NASA EJ data set to create a basic map.

	languages for environmental justice research such as Python and R. Select engaging video or guest speaker to relate specific programming skills to practical EJ use case.	applied to a real EJ use case.	basic functions to an EJ research case.	
Evaluation & Certification	TOPS OS101 for EJ Data Analysis Pathway Module 1 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Data Analysis Pathway Module 1 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Pathway Data Analysis Module 1 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.	TOPS OS101 for EJ Data Analysis Pathway Module 1 Badge Certification upon completion of short quiz. Exit survey will provide developers with community feedback for improving relevance, inclusivity, and accessibility.

Conclusion

The intersection of open science practice and equity & environmental justice movements is a promising area for research and capacity building. Institutional shifts prioritizing OS for EEJ should build capacity across the scientific process through iterative and community engaged processes of curriculum development to maximize relevance, address any accessibility and inclusivity concerns, and minimize curriculum developer bias. Building EJ community capacity in OS should increase participation of non-traditional background community researchers, resulting in novel research topics and approaches and cultivate an openness to non-academic knowledge including indigenous knowledge, local knowledge, and the knowledge of marginalized groups. Despite this potential, the intersection of open science and environmental justice lacks established literature and practice norms, highlighting the need for further research and for the development of innovative open science educational content for environmental justice audiences. The Building Open Science Skills for Environmental Justice Movements curriculum map suggests future directions for open science for environmental justice curriculum development and highlights potential areas that are targets for future funding proposals.

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APPENDIX A: SAMPLE MODULE TEMPLATE (Module 1, Session 1)

MODULE ONE: Introduction to Open Science for Environmental Justice

Total Sessions in Module One: 2 sessions which can be held on the same day with a short break or separated into two shorter sessions.

Total Module Length: ~2.5-3 hours

Module One Objectives:

This module introduces the core concepts and principles of open science, environmental justice, and the Communiversity model of community engaged academic supported research. Participants will engage with practical examples of successful environmental justice initiatives and discuss as a group how open science can support effective environmental justice work.

Target Audience: EJ community engaged researchers & EJ organizations members who want to build capacity in OS skills, tools, and resources.

SESSION 1: Core Concepts of Open Science and Environmental Justice

Session Length: ~1.5-2 hours

Learning Objectives:

- Introduction to the core concepts of open science.
- Introduction to environmental justice principles by engaging with guest speakers, video content, and/or case studies of successful environmental justice initiatives.
- Participation in a group discussion about the connections between open science and environmental justice principles.

Learning Activities:

Introduction (15 minutes):

- Briefly introduce the module topic and learning objectives.
- As a quick ice breaker, invite the group to share any relevant experience with the topics of this module or share their interest in the topic (what brings them to this course/module?).

Core Concepts of Open Science (25 minutes):

- Introduce open science and its core values with a brief video or videos.
- Choose a video you find most relevant to your group's needs. As a starting place here are a couple videos with concise answers to the question: 'What is open science?'

    - Check out this quick 5 min video defining open science from The National Royal Society.
    - Check out this video with one scientist giving a concise explanation of open science, along with some potential pros and cons of open science.

- After the video or videos, reiterate the key elements of open science.
- Refer to the Open Science resource PDF + relevant open science articles for further information.
- Introduce NASA Transform to Open Science mission, TOPS OS101 website and curriculum. If you have already taken the training or engaged with the materials, it would be good to contextualize the training if community members plan to earn badges.

Core Concepts of Environmental Justice (45 minutes):

- Introduce the concept of environmental justice and its core principles.
- If available, consider engaging a guest speaker with experience in environmental justice work to share about their experience.
- Consider sharing a video with a relevant speaker and/or a case study to present an engaging narrative example of environmental justice in action.

    - Check out these videos of Dr. Beverly Wright discussing EJ work
    - 5 Minute EPA Clip: https://youtu.be/9hE3SyXr9bw
    - 1 Minute Clip: https://www.aetv.com/videos/voices-magnified-dr-beverly-wright
    - ~1 hour lecture + ~ 30min Q&A. *There is some dead air at the beginning. Introductions begin around 16:50min mark, and lecture ends at about 1hr12mins*: https://www.youtube.com/watch?v=u-wtOlBs6sQ

- You could also present real-world case study yourself if you have EJ experience! Focus on projects relevant to your local context if possible.

    - Facilitate a group discussion on the case studies, exploring:
        - How open science practices were used in these projects.
        - The benefits of open science for addressing environmental justice issues.
        - Challenges faced by these projects and potential solutions.

Wrap-up Activity (30 minutes):

- After the session activities, ask participants to pair up discuss in small groups.
- Share with discussion partner or group:

- What was one thing that contributed to you better understanding the topics of open science and environmental justice than you did before?
- What if any questions do you still have? (Address briefly if possible and if discussion partner(s) have not already addressed; or if time does not allow note for future session and/or hare relevant resources for further exploration)
- How do you think you could apply the intersecting principles of open science and environmental justice to your current research question?

Assessment and/or Community Feedback on Curriculum:

- If assessment is desired and/or required (e.g. to earn TOPS badges), consider briefly going through the assessment questions and answers as a group to prepare for TOPS module completion later.
- Consider collecting brief feedback on the group's experience with the curriculum so you can adjust and/or improve upon it.

Resources:

Explanatory PDFs and supplemental articles will be linked in a Google Drive folder.

Facilitator Notes and Considerations:

- *This is meant to serve as a template and a guide. Please use what works, leave what doesn't, and adjust as you need to for your group's needs.*

APPENDIX B: SAMPLE MODULE TEMPLATE *(Blank)*

This blank template is intended to be a resource for facilitators and future curriculum developers. Please use what is useful and leave the rest. Everything here is included only as a suggestion. Adjust as suits your group's needs and your facilitation style. Flexibility and adaptability are crucial in any kind of facilitation and education environment. Think of this as a starting place, an outline, or a rough map if you find yourself in need of one.

Module Title

Total Sessions in Module: *Will the content be covered in one or multiple meetings or sessions?*

Total Module Length: *How long (minutes or hours) is it estimated to complete the entire module?*

Location & Time: *Virtual (link), Physical (Location, address), Time or Times*

Facilitator: *Who is presenting/guiding the discussion?*

Intended Audience: *Who is attending/learning?*

Session Number and Title

Session Length: *Minutes or hours*

Session Location: *Virtual (link), Physical (Location, address), Time*

Learning Objectives

- Learning Objective One
- Learning Objective Two
- Learning Objective Three
- Add as many objectives as you need, time allowing.

Learning Activities

Introduction (xx minutes) ****Including the approximate amount of time can help you stay on track as you facilitate or adjust in the future if you are way over/under allotted time.***

- Briefly introduce the module topic and learning objectives.
- Conduct a quick icebreaker activity which either engages the group in a brainstorm with the topic if the group is inexperienced with the topic, and/or invites sharing/storytelling if the group has experience with the topic.

Core Concepts (xx minutes)

- Find an engaging way to present the course content. Examples could be: multimedia material such as videos; interactive/experiential learning opportunities such as field visits or an engaged group learning exercise (do it together!) or

invite a guest speaker from your organization or community with experience in this topic to share their experience.

Wrap-up Activity (xx minutes)

- After the speaker/video/presentation/learning experience, facilitate a short group discussion about how it contributed to their understanding of the topic you are learning.

Assessment and/or Feedback (brief)

- Used to help facilitator to know if the core concepts are understood by participants so that adjustments can be made to future sessions and modules if necessary.

Resources

- Share links, documents, and other ways to continue to learn and engage with the topic if participants are interested in learning more or interested in returning to the session content later.

Facilitator Notes:

- Notes for you, if you are the facilitator, or for future facilitators if you are the curriculum developer.
- What would be helpful for you to remember as you facilitate? What would be helpful for future or fellow facilitators to keep in mind?
- Focus on key considerations for the most effective session (e.g. what are the group needs, what are your goals, what you feel should be emphasized, where could you or another facilitator improve to make it even better next time?)