Bridging the Disciplinary Divide: Promoting the Interdisciplinarity of Environmental Literacy in Teacher Education

Chelsea McClure[a], Sarah Haines[b]
[a, b] Towson University

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Abstract
Building knowledge, understanding, and advocacy for change in our environment is not just a topic for the science discipline but for every classroom, community, and individual. Because of that, environmental literacy is a pedagogy and practice that should be approached through leveraging interdisciplinarity as a teaching and training model. This paper reviews national, regional, and state initiatives around environmental literacy in the K-12 and higher education classrooms, highlighting the value of interdisciplinary environmental literacy and outlining a professional learning model. The Higher Education Environmental Literacy (HEEL) fellowship is a professional learning model focusing on capacity-building for a population often underrepresented in environmental literacy professional learning initiatives: teacher education faculty. By detailing the HEEL professional learning model, we describe strategies and educational experiences to promote engagement with environmental literacy through an interdisciplinary lens and share perspectives from HEEL faculty fellows.

Keywords: environmental literacy, environmental education, interdisciplinary education, teacher preparation, professional development, professional learning experiences, higher education faculty

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Introduction

"*...I think there should be a required course on environmental literacy demonstrating that the E-lit standards can be met in a multi- and interdisciplinary approach*."

-HEEL Faculty Fellow

This quote originated from a teacher education faculty member's reflection on recommendations for better preparing pre-service educators for teaching environmental literacy pedagogy, practices, and standards. Do you find yourself in agreement with this sentiment? As teacher education practitioners, we wholeheartedly embrace the message conveyed in this quote,

particularly its focus on the significance of environmental literacy from an interdisciplinary approach. A widely accepted meaning of environmental literacy from The North American Association of Environmental Education is awareness of and concern about the environment and its associated problems, as well as the knowledge, skills, and motivations to work toward solutions to current problems and the prevention of new ones (McBride et al., 2). No specific content area is referenced in that description, as environmental literacy is integral in all content areas to empowering youth to make informed decisions about environmental issues that affect themselves, their families, and their local and global communities within an increasingly complex and continually changing world.

When discussing environmental literacy, the term environmental issues encompasses multifaceted topics such as climate change, sustainability, environmental justice, socio-scientific issues, and cultural as well as historical connections that demonstrate the interconnectedness of humans and the environment. As environmental issues and topics are complex and not specific to one content area, neither are the benefits of environmental literacy as pedagogy and practice in the classroom. Environmental literacy as an environmental education objective provides benefits such as improving academic performance, enhancing critical thinking skills, and increasing civic engagement (Ardoin, 1). Therefore, with environmental literacy being emphasized as a rewarding practice to promote, we must support the integration of environmental literacy at every level of formal education and stress its interdisciplinary nature. To achieve this, exposure and training for educators at all levels to leverage interdisciplinary environmental literacy as a method of pedagogy in their classrooms is an essential practice. National, regional, and state-level initiatives foster this initiative of supporting the development of environmentally literate individuals and the integration of environmental literacy across content areas.

National Initiatives in the United States

Environmental Education Act

The Environmental Education Act (National Environmental Education Act), commonly known as the National Environmental Education Act (NEEA), is a significant piece of United States legislation promoting environmental literacy and stewardship. The act passed on November 16, 1990, highlights the necessity of incorporating environmental education within the nation's educational systems, from kindergarten to postsecondary study. Its major purpose is to provide individuals with the knowledge, skills, and attitudes required to confront environmental concerns and make informed environmental decisions. One of the key features of the Environmental Education Act is the establishment of the Office of Environmental Education within the Environmental Protection Agency (EPA). This office coordinates federal environmental education initiatives, provides grants to support environmental education programs, and collaborates with other government agencies, educational institutions, non-profit organizations, and community groups to advance environmental education efforts nationwide.

The legislation also permits federal, state, and local governments to support environmental education programs and projects. These monies go towards various activities, such as curriculum development, teacher training, environmental research, public awareness campaigns, and hands-on learning experiences. By investing in environmental education, the hope is to foster a society that prioritizes environmental protection, sustainability, and conservation. The Environmental Education Act promotes collaboration among schools, corporations, government agencies, and non-profit groups to improve the efficacy and reach of environmental education programs. Through collaboration and creativity, the act aims to enable

people of all ages to be responsible environmental stewards and active participants in crafting a more sustainable future.

No Child Left Inside

Sparked by Richard Louv's book "Last Child in the Woods", "No Child Left Inside" (NCLI) is a movement aimed at reconnecting children with the natural world. In an era where technology dominates much of our daily lives, NCLI advocates providing children with opportunities to engage in outdoor activities, environmental education, and hands-on experiences in nature. Dopko and Chawla (Dopko et al.) emphasize that the initiative recognizes nature's numerous benefits offered for children's physical, mental, and emotional well-being. At its core, NCLI emphasizes the importance of fostering a deep and meaningful connection between children and the environment. This connection is crucial not only for the health and happiness of individual children but also for the future of our planet.

By instilling in children a love and appreciation for nature, NCLI hopes to cultivate a generation of environmentally conscious citizens who are equipped to address the complex environmental challenges facing our world. NCLI initiatives can take various forms, including outdoor education programs, nature-based play and recreation opportunities, school curricula incorporating environmental themes, and community initiatives promoting access to natural spaces. These efforts aim to provide children with experiences that inspire curiosity, wonder, and a sense of stewardship for the natural world. Ultimately, No Child Left Inside seeks to ensure that every child has the opportunity to explore, learn from, and connect with the beauty and diversity of the natural environment.

Children and Nature Movement

Like the NCLI, The Children and Nature Network's (Children & Nature Network) aim is to connect all children, their families, and communities to nature through evidence-based resources and tools, broad-based collaboration, and grassroots leadership. With a shared mission motivated by concern for children's lack of connection with nature and the consequences for their health and well-being (Imai), this movement seeks to encourage and enable individuals, families, communities, and organizations to promote and support meaningful nature experiences for children. The movement advocates for more access to outdoor places, nature-based education, and support for unstructured nature play, all with the goal of promoting healthy child development. Advocates of the Children and Nature Movement believe that fostering this connection with the natural world is a vital step toward children being involved in environmental protection and stewardship throughout their lives.

The Children and Nature Movement understands the value of equality and inclusivity in ensuring that all children, regardless of background or circumstance, have access to nature-rich activities. Efforts are made to address access constraints such as socioeconomic inequality, urbanization, and safety concerns while also promoting diversity, equity, and inclusion within the movement. The Children and Nature Movement is a collaborative commitment to cultivating children's innate relationship with the natural world, with the objective of raising healthier, happier, and more environmentally conscious future generations.

Regional Initiatives

NOAA BWET

The NOAA BWET program, short for "Bay Watershed Education and Training," is an initiative launched by the National Oceanic and Atmospheric Administration (NOAA) in the United States (National Oceanic and Atmospheric Administration [NOAA]). This program focuses on fostering environmental stewardship and promoting watershed literacy among students and educators, primarily in the Chesapeake Bay watershed but also in other coastal regions across the nation.

The primary goal of the NOAA BWET program is to provide hands-on environmental education experiences that empower students to understand, appreciate, and protect their local watersheds and the broader marine environment. Through a combination of field trips, fieldwork, classroom instruction, and community-based projects, students gain valuable knowledge about watershed ecology, water quality, habitat restoration, and the interconnectedness of human activities and natural systems. The NOAA BWET program also strongly emphasizes professional development for educators, equipping them with the resources, training, and support they need to incorporate environmental science and stewardship into their curriculum effectively.

By empowering educators with the tools and knowledge to engage students in meaningful environmental learning experiences, the program aims to cultivate a generation of environmentally literate citizens who are equipped to address the complex environmental challenges facing their communities and the planet. Additionally, the NOAA BWET program fosters partnerships between schools, environmental organizations, government agencies, and other stakeholders to maximize the impact of environmental education efforts. Through

collaboration and shared expertise, the program leverages resources and expertise to reach a broader audience and implement innovative approaches to watershed education and conservation.

Meaningful Watershed Educational Experiences (MWEE)

The Meaningful Watershed Educational Experience (MWEE) is a significant element of NOAA's BWET program (Frungillo et al.). A MWEE is a holistic approach to environmental education that encourages kids to learn about their local watershed via hands-on activities. This experiential learning strategy extends standard classroom instruction by allowing students to actively explore, examine, and engage with the natural environment in their own communities. As McGuire-Nuss et al. and Kinne emphasize, a MWEE is built around the integration of several components, such as field investigations, classroom exercises, service-learning projects, and reflection (McGuire-Nuss et al.; Kinne). Students generally participate in outdoor field trips to local waterways, marshes, or other natural places to collect data, conduct experiments, and study the ecological processes and ecosystems that define their watershed. These field experiences lay the groundwork for greater learning and inquiry-based exploration after students return to the classroom.

In addition to fieldwork, MWEEs often include classroom lessons and activities that help students understand watershed ecology, water quality challenges, human influences on the environment, and the value of stewardship. By combining hands-on learning with classroom education, MWEEs give students a comprehensive grasp of watershed systems and the interconnectivity of natural and human systems. Service-learning projects are another important component of MWEEs, giving students the opportunity to apply their knowledge and abilities to real-world environmental concerns in their watersheds. These initiatives may include habitat

restoration, water quality monitoring, community outreach, and other activities that benefit the health and sustainability of local ecosystems. Service-learning helps kids build a feeling of agency and responsibility, as well as a stronger connection to the local watershed and a commitment to environmental preservation.

Reflection is an important part of the MWEE process because it allows students to critically analyze their experiences, thoughts, and actions, as well as contemplate how they may use what they've learned to affect good change in their communities and beyond. Through contemplation, students better understand environmental challenges' intricacies and the need for educated decision-making and civic engagement in dealing with them. Meaningful Watershed Educational Experiences offer students a transformative learning opportunity that promotes environmental literacy, critical thinking, stewardship, and civic responsibility. MWEEs foster long-term environmental awareness and participation by linking students with their local watershed and empowering them to conserve and restore its health.

State Initiatives

The State of Maryland has recognized the value of environmental education as part of the K-12 curriculum and has taken steps to ensure that all graduates of public high schools will be environmentally- literate citizens. The Maryland Partnership for Children in Nature was created to ensure that every child in every community experiences nature directly and develops a personal connection with our environment. These outdoor experiences build a sense of stewardship so that our children learn the principles associated with being responsible guardians of Maryland's natural resources. As one part of the State of Maryland's commitment to reconnecting children and nature, the Partnership for Children in Nature Executive Order was signed. This Executive Order formed a public-private partnership that provided structured and

unstructured play activities for children outdoors. The Partnership's 21-member board is tasked with finding creative ways to enable children throughout our State to get outside and learn about nature and make environmental literacy a part of every curriculum.

In 2012, Maryland became the first US state to mandate a high school Environmental Literacy graduation requirement (Maryland State Department of Education). This mandate ensures all Maryland youth are provided with a comprehensive, multi-disciplinary environmental literacy program infused within current curricular offerings and aligned with the Maryland Environmental Literacy Standards. The Environmental Literacy Program shall provide a developmentally appropriate instructional program with opportunities focused on outdoor learning experiences, advancing students' knowledge, confidence, skills, and motivation to make decisions and take actions that preserve and protect the unique natural resources of Maryland and the Chesapeake Bay and its watershed and provide for the diversity of student needs, abilities, and interests at the early, middle, and high school learning years. In 2014, the Chesapeake Bay Watershed Agreement reaffirmed the aspirations for an environmentally literate student population and included provisions for students to receive Meaningful Watershed Educational Experiences in elementary, middle, and high school. The agreement was signed by the governors of the six states within the Bay watershed, the mayor of the District of Columbia, the leader for the Chesapeake Bay Commission, and the Director of the Environmental Protection Agency. For students to receive high-quality and rigorous instruction to meet the Maryland Environmental Literacy standards, effective professional development for teachers must ensue.

While the Environmental Literacy standards have promoted K-12 students collecting environmental data, outdoor learning, and stewardship action, it has become evident that since the COMAR requirement became law in 2012, in-service teachers have reported not feeling

prepared to teach environmentally-literate practices. Focusing on this need in teacher preparation, in 2024, the Maryland Outdoor Learning Network was formed out of The Partnership, via executive order. The executive order specifies the responsibilities to include the following:

- Recommend and facilitate statewide actions needed to meet established priorities, convening partners to address gaps, recommending realignment of resources such as funding and improvement of coordination among and across public and private programs to efficiently advance outcomes.
- Develop recommendations to help shape state policy and stakeholder practices to address barriers, needs, and opportunities identified by the initiative.
- Broaden engagement of stakeholders in the initiative's work and help establish the tools and resources necessary to advance the work of the group.

The most recent report sent to the governor by the Maryland Outdoor Learning Network recommends that relevant entities incorporate an environmental literacy pre-service component into teacher education curricula in Maryland Institutes of Higher Education. This includes strategies such as infusing effective environmental literacy content into coursework in different disciplines, creating credential opportunities, and adding environmental literacy to certification requirements and regulations.

While the initiatives described above have made significant strides in advancing environmental education for K-12 students, they often overlook a critical component of effective education: higher education and the training of faculty, particularly those who teach pre-service teachers. These national and regional initiatives primarily focus on engaging younger students and developing curricula tailored to primary and secondary education settings. However, they

frequently fall short in addressing the professional development needs of higher education instructors who play a crucial role in shaping the next generation of K-12 teachers. Without adequate training for higher education instructors, the integration of environmental literacy into teacher preparation —and thus K-12 education— remains inconsistent and often limited in depth and scope. Higher education instructors, who are instrumental in preparing future educators, require specialized training to effectively teach and model environmental literacy. This gap in professional development can lead to missed opportunities for fostering a comprehensive understanding of environmental issues among pre-service teachers. The innovative program we describe below seeks to bridge this gap by focusing specifically on equipping higher education faculty with the skills, knowledge, and pedagogical strategies necessary to enhance their students' environmental literacy. By targeting higher education professionals, this program aims to create a ripple effect that enhances environmental literacy across all levels of education and ensures a well-rounded, interdisciplinary approach to addressing complex environmental challenges.

The Higher Education Environmental Literacy Initiative:

The Higher Education Environmental Literacy (HEEL) initiative blossomed out of the national, regional and state emphasis on environmental literacy with the aim to support capacity building by targeting higher education faculty engaged with teacher preparation. HEEL is a collaborative initiative developed through active community partnerships between Maryland Institutes of Higher Education faculty members, the Maryland Association of Environmental & Outdoor Education (MAEOE), informal environmental educators, and state government representatives. Through this collaboration, the HEEL leadership team integrated diverse perspectives and was representative of a broad range of experiences with environmental literacy. This multifaceted

team designed the HEEL initiative into a HEEL fellowship model by constructing a semester-long professional learning experience tailored to teacher education faculty members from Maryland Institutes of Higher Education. The HEEL fellowship objectives were to build the capacity of higher education faculty around integrating environmental literacy pedagogy, practices, and standards into their coursework, as well as to cultivate an environmental literacy professional learning community of higher education faculty. Building faculty participants' capacity to model best practices in their higher education classrooms creates the opportunity for those faculty to expose pre-service teachers to pedagogy to emulate in their own future classrooms.

The HEEL fellowship cohorts engaged teacher education faculty members from nine different Institutions of Higher Education across Maryland in Spring 2023-Spring 2024. By providing environmental literacy pedagogy and practices to faculty through the HEEL fellowship, we exposed them to research-based practices for effective environmental literacy, hands-on learning, reflective practice, and strategies for integrating environmental literacy through an interdisciplinary perspective.

Interdisciplinarity of Environmental Literacy

Interdisciplinarity is described as learning knowledge from one or more disciplines, specifically through collaboration and interaction between disciplines (Janoušková). Leveraging interdisciplinarity as a learning model provides opportunities to increase environmental literacy and the understanding and development of solutions to environmental issues (J. Martínez-Ventura; Steele & Stier). It is essential for individuals to develop the ability to use information and skills across multiple subject domains to be able to develop a comprehensive understanding of myriads of causes, interactions, and consequences of environmental issues and

decisions pertaining to the environment (Nuhoğlu et al.). Environmental literacy across disciplines demonstrates the interconnected nature of environmental topics between natural systems, society, culture, economy, ethics, policies, and varying viewpoints, to name a few. Each of these topics can differ regarding location, time, and individuals affected or affecting that environment; because of that, environmental literacy is a valuable topic to incorporate into all content area classrooms. The HEEL fellowship promotes the perspective of interdisciplinarity for environmental literacy as a pedagogy and practice that transcends the single-discipline boundaries to build bridges between content areas through environmental literacy.

To integrate the practice of interdisciplinarity into teaching environmental literacy at all levels of education, we recommend focusing on early integration into teacher education training during programming in higher education. By building capacity for environmental literacy and the mindset of interdisciplinarity in conjunction, the HEEL fellowship focuses on integrating environmental literacy pedagogy and practices in teacher training by providing faculty the experience of engaging with environmental literacy pedagogy and practices while reflecting on future application in their own classrooms, otherwise known as tandem perspective practice (McClure).

Tandem Perspective Practice

We promote professional learning opportunities for environmental literacy pedagogy and practices to begin for pre-service teachers during teacher education courses related to their field of study and/or anticipated certification subject area. To support higher education integration of environmental literacy into the pivotal years of teacher education training, the HEEL fellowship focuses on teacher education faculty capacity building. By empowering faculty to reflect on environmental literacy practices across content areas critically, the HEEL fellowship cultivates

unique integrations of environmental literacy into different teacher education programming, courses, and content areas. A key component of the HEEL professional learning model is actively engaging faculty in tandem perspective practice. McClure defines tandem perspective practice as a strategy for professional learning that engages participants in the role and perspective of the student while simultaneously reflecting on the teacher's perspective of how to facilitate and differentiate the information for their own classrooms (McClure). This allows the HEEL professional learning participants to actively engage and experience the environmental literacy practices as well as be able to engage in reflective practice to differentiate that activity for their own content area, diverse student needs, and local context. As shown in Figure 1, HEEL utilizes this reflective practice model by placing faculty fellows in the role of student and teacher throughout the professional learning experiences, which provides a unique vantage point for the learning experiences. We encourage the use of tandem perspective practice as a tool for capacity building in the application of environmental literacy knowledge, skills, and actions to future classrooms.

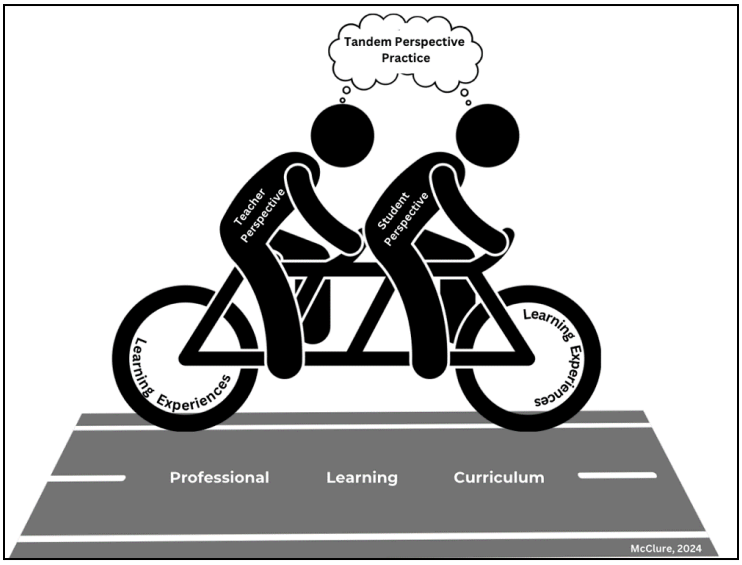

Fig. 1 Visual Representation of the Tandem Perspective Practice (TAPP) Learning Model (McClure)

HEEL Fellowship Themes and Interdisciplinary Activities

The HEEL fellowship professional learning experience format was hybrid, including both asynchronous learning modules and in-person professional development sessions. During the asynchronous modules, faculty participants engaged with five professional learning sequences, each emphasizing environmental literacy pedagogy and practices in teacher education and the impact of an interdisciplinary lens when teaching environmental literacy. Asynchronous module themes exposed participants to research-based best practices and curriculum-based pedagogy to engage with various environmental literacy topics. The HEEL module themes follow a sequential order arranged to lead into and build onto each other. As shown in Figure 2, the module themes were: What is Environmental Literacy and Why is it Important; Application of Environmental Literacy to Your Higher Education Classroom; Navigating Outdoor Learning; Creating Meaning Through Issue Investigation; and Diversity, Equity, Inclusion, Justice, and Accessibility.

Fig. 2 HEEL Professional Learning Asynchronous Module Themes and Key Concepts

A unique component of the HEEL fellowship was that the interdisciplinarity of environmental literacy was not just integrated into the curriculum, but the faculty participants themselves embodied the concept of interdisciplinarity through the professional learning community. HEEL fellows represented faculty from a range of teacher education content areas such as math, elementary education, multilingual learner education, environmental studies, secondary education, and science. This was a focus when developing the HEEL fellowship that it was not just a professional learning experience for science teacher education faculty but instead promoted the same mindset that we advocate for in K-12 and teacher education programming, that every individual and content area has a stake, a connection, a perspective, and an impact on the future of our environment. Having a blend of disciplines represented within teacher education created opportunities for new ideas to grow out of collaboration between different Institutes of Higher Education and content areas in teacher education that may not have crossed paths or considered the connections between their discipline areas before. While leveraging their own content expertise, we provided learning experiences and a collaborative platform to share ideas and engage with the interdisciplinarity of environmental literacy throughout the professional learning in person and infused throughout the modules. Figure 3 displays examples of HEEL curriculum activities that were used to promote the interdisciplinarity of environmental literacy across content classrooms.

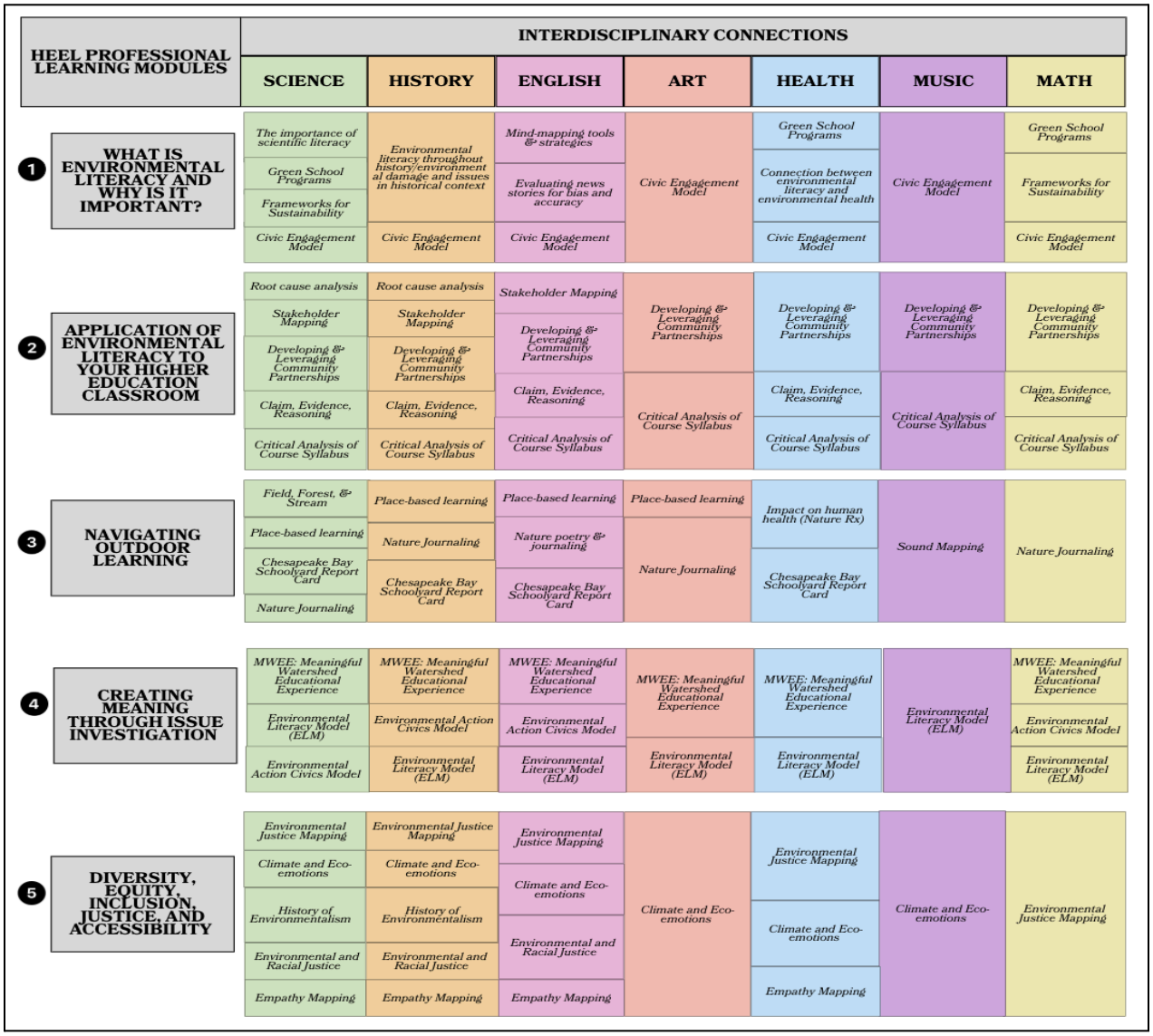

Fig. 3 HEEL Professional Learning Interdisciplinary Environmental Literacy Activity Examples

Reflections and Recommendations

Throughout the HEEL fellowship, participants actively engaged with interdisciplinary environmental literacy through a tandem perspective practice learning model while collaborating in a teacher education faculty professional learning community. At the conclusion of the semester-long HEEL fellowship, faculty participants self-reported their reflections on the

application of environmental literacy to teacher education through a comprehensive questionnaire. This instrument encompassed Likert-scale items, multiple-choice questions, and opportunities for written commentary. The reflections provided insight into faculty perspectives on the interdisciplinarity of environmental literacy and recommendations for supporting the integration of environmental literacy into teacher education preparation programming. When reporting motivations to engage in environmental literacy professional development, 85% of HEEL fellows reported through multiple-choice selection that one of their motivations was their belief in interdisciplinary education. As depicted in Figure 4, the frequent response endorsed the notion that interdisciplinarity serves as a valuable lens for cultivating environmental literacy. In addition to HEEL fellows' belief in interdisciplinary education, motivation factors reported were pre-service teacher preparation, the belief that it is important that students be environmentally literate for the good of future generations, environmental literacy makes learning fun for my students, and environmental literacy makes learning relevant to my students. Overall, it provides valuable insight into faculty perspectives on the integration of environmental literacy in pre-service teacher education.

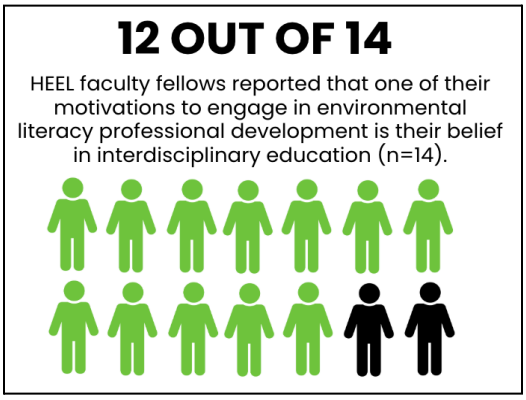

Fig. 4 HEEL Faculty Fellows Self-Reported Likert-scale Question on Motivation and Belief in Interdisciplinary Education

Along with reflecting on their motivations as faculty for engaging in environmental literacy professional learning, HEEL participants reflected on their recommendations for better preparing pre-service educators to integrate environmental literacy. As depicted in Figure 5, anecdotal evidence from HEEL fellow's written reflections demonstrated recommendations such as more opportunities for learning environmental literacy, interdisciplinary partnerships and experiences, and environmental literacy course requirements to demonstrate interdisciplinary approaches.

Fig. 5 HEEL Faculty Fellows Self-Reported Recommendations for Environmental Literacy Preparation in Teacher Education Programming

These recommendations highlight the key idea of environmental literacy as a pedagogy and practice to promote in teacher education programming. Just as environmental literacy is the foundation for addressing environmental issues and challenges, pre-service teacher education must be the foundation for environmental literacy capacity building. Preparing our future educators to draw connections to the environment and build bridges across the curriculum is essential for an effective teaching practice. To reach this objective, we emphasize the importance of professional learning opportunities such as the HEEL fellowship to provide faculty

experiences with the implementation of environmental literacy as a pedagogy and practice across pre-service teacher education programming.

Throughout this article, we provided a review of national, regional and state initiatives around environmental literacy in the K-12 and higher education classrooms, emphasized the value of interdisciplinary perspectives in professional learning, and highlighted the innovative initiative of the HEEL fellowship as a professional learning model. In response to HEEL fellow reflections and HEEL facilitator experiences, we provide recommendations for continued support of avenues for faculty to actively engage with environmental literacy, to promote tandem perspective practice from the lens of teacher education, and to facilitate interdisciplinarity as a mode of teaching and learning. Environmental literacy cannot be siloed to the science discipline; we must build bridges to encompass multifaceted environmental topics across content areas to support future generations and our complex, ever-changing world. By emphasizing the HEEL framework and areas of focus, we draw attention to the interdisciplinarity of environmental literacy in teacher education and higher education faculty environmental literacy professional learning as avenues for further research, inquiry, and exploration.

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Chelsea McClure is an adjunct professor in the Department of Secondary and Middle School Education in the College of Education at Towson University, Towson, Maryland.

Sarah Haines is a professor of Biological Sciences and Science Education in the Fisher College of Science and Mathematics at Towson University, Towson, Maryland.

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