Imagine small groups of students scattered about a natural area adjacent to their school. One group is identifying local plant life using a field guide. They are choosing plants that will be part of their Nature Gallery that they will share with other students. Another group has a microphone connected to an iPod and is trying to record the sounds of cicadas for use in a podcast they are creating about how insects communicate. Finally, another group is using mobile technology to collect stream data. This data will be incorporated into a larger watershed management study that uses Google Earth tools. Ultimately, they are all engaged in place-based, meaningful, and active learning experiences.

As the students work, their teacher walks around the natural area observing, questioning, and advising the students on their projects. As she moves to the next group, she thinks to herself how lucky she was to have had rich pedagogical environmental education experiences during her preservice teacher preparation. These experiences prepared her to maximize learning for field trips in outdoor settings, supplied her with environmental education curriculum content, taught her that environmental education is interdisciplinary and that technology can be used appropriately to enhance outdoor explorations and investigations. This preparation really made the difference for her class. The students seem to grasp new concepts much more quickly when they are provided with active learning experiences and truly understand how many important science concepts, ideas, and learning approaches transcend discrete subject areas.

This vision summarizes the hope that the editors of this book and the Association for Science Teacher Education (ASTE) Environmental Education forum members have for the improvement of integrating environmental education (EE) into science teacher preparation. According to the NSF report, Complex Environmental Systems: Synthesis for Earth, Life, and Society in the 21st Century (Pfirman and AC-ERE 2003), in the coming decades, the public will be called upon more frequently to understand complex environmental issues, evaluate proposed environmental plans, and understand how individual decisions affect the environment at local to global scales. The report calls for raising the environmental literacy of the general public by providing quality environmental education and training. Support for environmental education (EE) in school curricula has been well established, with 95% of the general public supporting the teaching of EE in schools (NEETF/Roper 2001). However, there has been no significant progress in incorporating EE into K-12 school curricula (NEETF/Roper 2001; Ramsey et al. 1998).

Studies published during 1995–2005 and reviewed by the State Education and Environment Roundtable (SEER) have shown that schools that do manage to
incorporate EE programs demonstrate significant growth in student achievement and improved student behavior. For example, the SEER publication *Closing the Achievement Gap: Using Environment as an Integrating Context for Learning* (Lieberman and Hoody 1998) indicated that students in schools that incorporate EE improved in standardized test scores; science, mathematics, and literacy achievement; problem-solving and critical thinking skills; and improved overall grade point average. However, in order for such learning benefits to occur, teachers must be willing and able to support the integration of EE in the K-12 curriculum.

One of the reasons that the K-12 EE integration is rare is that many preservice teacher education programs do not incorporate EE into their programs of study (Rakow 1985; McKeown-Ice 2000). In a national survey of 715 teacher education institutions, McKeown-Ice (2000) found that only half of the surveyed students in preservice programs received exposure to EE. Barriers to including EE in preservice teacher education programs include a lack of faculty knowledge about EE, the inflexible structure of preservice teacher education courses, lack of EE standards in teacher accreditation and certification requirements, and curriculum time constraints in the teacher education curriculum (Scott 1996; McKeown-Ice 2000).

While studies indicate that there are many benefits to incorporating EE into preservice teacher education, the current extent to which it is incorporated is low. When preservice EE preparation is implemented, the treatment of EE is often shallow (Heimlich et al. 2004; McKeown-Ice 2000; Lane et al. 1995). These studies noted that teachers were not confident to enter classrooms and implement EE pedagogical methodologies, including curricular teaching and learning strategies after completing their education training. To increase EE curriculum integration in our schools, teachers must be confident and willing to incorporate EE pedagogical practices and learning activities in their classrooms.

Environmental education, when taught in school settings, is predominantly integrated into a school’s science curriculum. Often, it is taught within earth and environmental science topic areas pertaining to ecosystems and environmental issues such as energy, climate change, pollution, and natural resources. EE teaching and learning also commonly occurs in life sciences topic areas that include biodiversity, endangered species, and genetic engineering. These discipline-based topic areas are covered in most basal science textbooks curriculum programs that are marketed to schools for adoption (McComas 2002; Wilson 2000). Most states incorporate EE-related content within their state science standards. While a few states such as Pennsylvania (Pennsylvania Department of Education 2002) and Wisconsin (Wisconsin Department of Public Instruction 1998) have academic standards for EE, such states do not require an EE course for high-school graduation nor do they prescribe how EE should be taught at the local level. In most states, EE-related content is integrated into science curriculum standards (No Child Left Inside Coalition 2009) and is assessed to some degree on high-stakes state science testing. That said, there has been a recent national resurgence of EE through the proposed *No Child Left Inside Act of 2009* legislation to advance environmental education in US schools through the creation of state environmental literacy plans.
Through the integration of EE within the context of science teacher preparation, preservice and inservice teachers can become aware of teaching and learning strategies for cognitive, affective, and behavioral goals of EE and can help their students with becoming environmentally literate. This book focuses on the inclusion of EE content and pedagogy in science teacher preparation as it applies towards instructional practices in K-12 science classrooms, early childhood settings, and other learning environments. EE goals include developing citizens that are aware of and concerned about the environment and its associated problems. To achieve these goals, science teacher educators need to prepare preservice and inservice teachers with knowledge of EE understandings and essential skills to ensure that their future students will have opportunities to acquire knowledge, values, attitudes, and commitment to protect and improve the environment. In science teacher preparation, this involves the teaching and learning of pedagogical approaches for creative problem-solving skills, scientific and social literacy, ethical awareness and sensitivity for the relationship between humans and the environment, making informed decisions, and commitment to engage in responsible actions.

**About This Book**

The purpose of this book is to share knowledge and ideas about EE pedagogy in the context of science teacher preparation as it applies to teaching and learning in K-12 science classrooms and their associated learning environments. The chapters in this book share, examine, and discuss EE foundations and pedagogical principles through theoretical and practical applications as it primarily pertains to the preparation of preservice and inservice science teachers. This book is designed to inform science teacher educators about the historical and philosophical underpinnings of EE, current trends in EE as it pertains to science teacher education, and EE-specific pedagogical practices and content-pedagogical knowledge as it applies to science teacher education. The book includes a series of case studies that highlight the teaching and learning of EE content and concepts in science teacher education. Some chapters highlight EE exemplary practice with K-12 and early childhood students in traditional classroom settings in addition to nontraditional instructional settings such as outdoor and field-trip settings. In addition, this book describes innovative science teacher preparation programs that have found ways to address the barriers to EE integration that are inherent to many teacher preparation programs.

A few key themes permeate across the book chapters:

1. *Inquiry-based teaching and learning is an integral part of EE.* EE instructional methods such as role-playing simulations, naturalistic inquiry, and field investigations incorporate essential features of inquiry (National Research Council 2001).
2. **EE is multidisciplinary and provides many applications for the teaching and learning of science.** In addition to developing science content knowledge and science process skills, EE incorporates a multidisciplinary approach to learning that incorporates problem-solving, critical thinking, and literacy skills, that are each inherent to other core school disciplines.

3. **It is important to provide preservice and inservice teachers with professional development experiences in outdoor settings.** Preservice teachers have a lack of comfort in outdoor settings as a location for learning, and most having no experience with learning outside of a traditional classroom.

4. **EE is a collaborative endeavor.** It is not necessary to include EE into science teacher education in isolation. EE educators based in a variety of settings are available to collaborate in innovative ways with science teacher educators to promote science and environmental literacy.

The primary audience for this book is science teacher educators. That said, the chapters in the book will appeal to a wide audience including faculty in teacher preparation programs, classroom science teachers, and environmental educators who work with preservice teachers, inservice teachers, and K-12 and early childhood learners.

**What’s in the Book?**

The book is organized into two main sections: (i) *Introduction to Environmental Education* and (ii) *Environmental Education Pedagogy*.

*Introduction to Environmental Education* discusses the historical and philosophical foundations of EE, how environmental science is different from EE, and current trends in EE as it pertains to science teacher education with a focus on inquiry-based teaching and learning, learning environments including early childhood settings, service learning, and ocean and aquatic sciences.

In the chapter “The History and Philosophy of Environmental Education,” Carter and Simmons present the tumultuous history of EE and describe its relationship to other disciplines and fields of study. The chapter traces the historical and philosophical development of the EE field and relates EE as presently practiced to the mosaic of K-12 education with a focus on its relationship to science education. This chapter lays the foundation for further discussion of EE’s place in the education of teachers of science for the twenty-first century.

In the chapter “Professional Preparation for Science Teachers in Environmental Education,” McDonald and Dominguez discuss the importance of professional preparation for science teachers in EE. They describe reasons for why the professional preparation of including EE in teacher preparation programs has become a complex issue. The authors illustrate how the *National Science Education Standards* (NRC 1996) and the *Guidelines for the Initial Preparation of Environmental Education* (NRC 1996) can guide the preparation of science teacher educators in EE.
Educators (NAAEE 2000) provide guidance to how preservice teachers should be prepared to implement EE in K-12 classroom environments.

In the chapter “Approaches to Environmental Education,” Winther, Sadler, and Saunders provide an overview of various teaching and learning approaches that exist within the field of EE. Like science education, environmental education is an interdisciplinary and complex field that offers a multitude of strategies for learning, dependent upon the variables of resources, time, space, curriculum, student characteristics, plus a full range of factors that can affect any kind of educational implementation.

In the chapter “Environmental Education Within the Early Childhood,” Plevyak and Mayfield discuss incorporating EE into early childhood settings. They emphasize the importance of using EE as an integrated curricular context and provide many examples of how EE can be infused across the many different disciplinary areas taught in early childhood classrooms. Special emphasis is placed on acquiring knowledge about the environment, developing an environmental ethic, adapting EE activities for inclusion of students with special needs, and the use of assessment techniques.

In the chapter “Environmental Education Service-Learning in Science Teacher Education,” Phillipson-Mower and Adams explore the history, theory, and use of service-learning as it relates to EE and teacher preparation. The authors describe instructional methods that engage both preservice and inservice teachers as well as classroom students in citizenship through decision-making, research, and community-building skills that meet the goals for both science and environmental education.

In the chapter “Beyond Terra Firma: Bringing Ocean and Aquatic Sciences to Environmental and Science Teacher Education,” Payne and Zimmerman discuss the lack of ocean and aquatic science in environmental and science teacher education. The authors contend that such content is essential to global Earth systems science literacy. The chapter describes many resources designed to provide teacher educators and classroom teachers with tools to enhance the existing curriculum through the integration of ocean and aquatic sciences in their instruction.

The Environmental Education Pedagogy section is divided into three subsections that apply to science teacher preparation. These include (1) Outdoor Learning and Place-Based Environments, (2) Instructional Strategies, and (3) Technology.

Outdoor Learning and Place-Based Environments discuss teaching and learning in nontraditional learning environments. This section includes chapters on outdoor learning spaces, field-trip strategies, elementary teacher learning, and learning about local plant life. Three case studies are presented that include (1) EE classroom implementation of inservice teachers in an outdoor professional development program, (2) a service learning program, and (3) an urban education program.

In the chapter “Promoting the Use of Outdoor Learning Spaces by K-12 Inservice Science Teachers Through an Outdoor Professional Development Experience,” Bloom, Holden, Sawey, and Weinburgh describe a summer professional development program designed to encourage inservice elementary and secondary school teachers to use outdoor learning spaces (OLSs) as part of their curriculum. As part of the professional development design, the authors identify
the teachers’ perceived and actual obstacles to integrating OLSs and then
designed the professional development experiences to specifically address these.
The authors provide recommendations for others who are considering develop-
ing professional development programs to promote the use of OLSs with K-12
teachers.

In the chapter “Integrating Environmental Education Field Trip Pedagogy into
Science Teacher Preparation,” Rebar and Enochs discuss how preservice science
methods courses can make use of field trips to enhance EE integration into preser-
vice teacher education programs. The authors describe a variety of research-based
strategies for optimizing learning on field trips with secondary students. The
authors provide practical implementation strategies and examples that illustrate that
including field-trip pedagogy in the existing science methods courses may be
accomplished without restructuring course objectives and without displacing other
important materials to be covered.

In the chapter “‘Eeew! There’s Dew On My Toes’: Common Characteristics of
Preservice Elementary Teacher Learning in Environmental Education and
Instructional Strategies for Science Teacher Educators,” Hug describes important
characteristics of preservice elementary school teachers that science teacher educa-
tors should understand in order to consider integrating EE activities into science
methods course work. Chapter vignettes focus on inadequate content knowledge,
ecophobia, avoidance of minor physical discomfort, and a need for highly struc-
tured learning environments. Instructional strategies and learning experiences are
discussed to address these characteristics.

In the chapter “Name That Plant! Overcoming Plant Blindness and Developing
a Sense of Place Using Science and Environmental Education,” Frisch, Unwin, and
Saunders describe “plant blindness,” a phenomenon that attempts to explain why
botanical education is often neglected in the implementation of school curricula,
and why people have so much trouble “seeing” plants. The authors suggest that
plants can and should be an integral part of life science education. They advocate
place-based pedagogical practices that provide teachers and students the chance to
learn about and explore plant life in their communities to enhance their environ-
mental awareness and sense of place.

In the chapter “Place-Based Inquiry: Advancing Environmental Education in
Science Teacher Preparation,” Sarkar and Frazier describe a 3-year professional
development project for inservice science teachers to implement place-based peda-
gogy and EE in science classrooms. The authors provide a framework for planning
successful place-based investigations. Case studies are presented where teachers
with their students engage in inquiry-based, place-based investigations for an
extended period of time. The authors also discuss how place-based pedagogy is
important for the preparation of science teachers and how such a strategy addresses
a range of science concepts through deeper inquiry.

In the chapter “Summer Methods in Summer Camps: Teaching Projects WILD,
WET, and Learning Tree at an Outdoor Environmental Education Center,” Eick,
Carrier, Perez, and Keasal describe an innovative partnership program in which
elementary and secondary science preservice teachers at Auburn University teach
EE to summer camp children at the university’s outdoor environmental education center as part of their first science methods course. The preservice teachers receive training in the use of Project curricula including Projects WILD, WET, and Learning Tree from a Cooperative Extension Specialist. The chapter describes the camp experiences and how the Project curricula are integrated into instruction.

In the chapter “Teachers Connecting Urban Students to Their Environment,” Brown, Votaw, and Tretter describe the Science Beyond the Classroom program, a 10-day Hands-on, Minds-on Summer Science Camp led by preservice and inservice teachers for urban, low-SES middle-school students to learn about environmental science concepts through site visits to environmental community-based venues. The program is designed to nurture positive attitudes of urban students toward environmental science learning by increasing awareness of science in their community. As a result of participating in this innovative professional development program, K-12 inservice and preservice teachers gained an enduring awareness of the impact that they can have on the environment.

Instructional Strategies discusses specific instructional strategies for the inclusion of EE in science teacher professional development. This section includes chapters on instructional methods to elicit learner EE conceptions, use of concept mapping to promote EE knowledge and understandings, Science-Technology-Society role-playing simulations with environmental issues, problem-based learning methodologies, and collaborative activities between science teacher methods instructors and nonformal environmental educators.

In the chapter “Exploring Preservice Teachers’ Mental Models of the Environment,” Moseley, Desjean-Perrotta, and Crim describe the development of the Draw-An-Environment Test (DAET), a survey tool designed to uncover preservice teachers’ mental models of the environment and a rubric, based on the NAAEE Guidelines for the Preparation and Professional Development of Environmental Educators for scoring the drawings produced in the DAET. The authors present their implementation findings from a sample of preservice teachers. The authors describe how their data findings influenced programmatic changes in their certification program.

In the chapter “Pedagogy, Environmental Education, and Context: Promoting Knowledge Through Concept Mapping,” Austin and Schmidt describe how they used regional environmental questions to model concept mapping for content learning and collaborative learning with their secondary science methods students. They describe how their project used concept mapping activities to incorporate collaborative learning to develop a curriculum that promoted EE learning with a focus on the interdisciplinary nature of science, while integrating discipline-specific content standards.

In the chapter “Unraveling the Scientific, Social, Political and Economic Dimensions of Environmental Issues Through Role-Playing Simulations,” MaKinster describes the implementation of a United States Senate Subcommittee hearing role-playing simulation on the use of Bt (Bacillus thuringiensis) genes in corn in a college-level interdisciplinary science course that is taken by many preservice teachers. The simulation incorporated a wide variety of teaching strategies and topics that are
of current interest in science education including simulations, role-playing, driving questions, oral presentations, technology integration, portfolios, reflection, and concept mapping. The implementation findings demonstrated that environmental role-playing simulations can have a significant impact on students’ understanding of how science is applied to environmental problems.

In the chapter “Exploring Environmental Education Through Eco-feminism: Narratives of Embodiment of Science,” Spencer and Nichols discuss how care must be taken when teaching about the environment whether the underlying philosophical framework is one of sustainability, deep ecology, bioregionalism, or ecofeminism. The authors describe how problems-based learning as a pedagogical practice at first seems to be a logical way to learn about nature. However, the authors discuss problems with using this teaching strategy with EE topics from an ecofeminist perspective.

In the chapter “The Value of Nonformal Environmental Education-Based Professional Development in Preservice Science Teacher Preparation,” Peffer and Bodzin describe the work of nonformal EE educators and discuss their potential role in science teacher preparation programs. Nonformal EE educators use a wide assortment of teaching methodologies in varying learning environments to encourage an environmentally literate citizenry. The benefits of collaborative relationships between nonformal EE educators and science teacher educators are discussed.

In the chapter “Using Environmental Education Project Curricula with Elementary Preservice Teachers,” Schepige, Morrell, Smith-Walters, Sadler, Munck, and Rainboth describe the use of the Project curricula – Project WET, Project WILD, Project WILD Aquatic, and Project Learning Tree – as a means of introducing environmental education in preservice university courses. Four different case studies demonstrate diverse methods of integrating EE through the use of the Project Guides into preservice teacher coursework at four different universities. The authors describe how their instructional approaches strengthen elementary preservice teachers’ science content knowledge, develop science process and inquiry skills, integrate literacy, and embed field work in educational settings.

Technology discusses the integration of technology to promote the teaching and learning of EE in science teacher preparation. This section includes chapters on instructional methods to incorporate geospatial technologies (including Google Earth and Geographic Information Systems), podcasts, and web-based inquiry activities in science teacher professional development coursework.

In the chapter “Situated Learning in Environmental Education: Using Geospatial Technologies with Preservice Secondary Teachers,” Hagevik, Stubbs, and Whitaker describe how situated learning using Geospatial Information Technologies (GIT) in preservice teacher education courses can be used to study the environment. They describe how nature study and GIT were used in science teacher education courses on campus and through field experience courses in diverse natural locations. The courses promoted collaborative learning communities, where students became immersed in the natural world and were able to investigate their own investigative questions.
In the chapter “Using Podcasting to Address Nature-Deficit Disorder,” Klein and Weaver discuss the issues associated with the digital native student population and their disconnection with the natural world. The authors describe two preservice teacher education podcast projects that integrate technology to encourage student connections with nature. In these projects, preservice teachers develop podcasts that are used as learning tools for outdoor field settings with elementary and secondary school students.

In the chapter “Integrating Web-Based Activities and Site-Based Experiences to Investigate Environmental Issues,” Bodzin describes how an EE course at Lehigh University uses a hybrid approach of instruction using web-based activities and face-to-face site-based experiences to primarily focus on the study of environmental issues in the Lehigh River watershed. Course activities are presented that illustrate how technology can be used effectively to support EE teaching and learning with prospective and current science teachers. The chapter describes how course materials take advantage of easily available geospatial information technologies to foster spatial literacy in the curriculum and support learners with the ability to make use of data visualizations for analysis and interpretation when examining environmental issues such as sprawl and land use decision-making.

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