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# Bridging Research, Curriculum, and Practice: An Experiential Model for STEM Access

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## Abstract

*The Desert Research Institute's (DRI) STEM Education Program has provided innovative and accessible science, technology, engineering, and mathematics (STEM) learning opportunities for over a decade. Designed to address barriers to high-quality STEM education, this program combines hands-on curricula with educator professional development training to create sustainable pathways from student engagement to STEM careers.*

*Specifically, the Green Box Program develops and distributes reusable, self-contained curriculum kits that align with national science standards and include all materials necessary to deliver 3–4 weeks of classroom instruction. Each Green Box highlights environmental research being conducted by DRI scientists and incorporates career profiles to connect students' classroom experiences with authentic STEM applications and pathways. Educators reserve boxes for one academic quarter, after which they are returned, restocked, and recirculated. This model reduces costs, eliminates barriers associated with lab materials or equipment, and creates opportunity for the authentic exploration of STEM topics and careers.*

*Complementing the curriculum, DRI offers educator professional development trainings that prepare educators to implement experiential and inquiry-based instruction with confidence. These trainings provide adaptable strategies for diverse learning environments and foster professional communities of practice. Educators consistently report increased readiness to apply inquiry-based methods, improved ability to connect students with real-world science, and stronger confidence in facilitating hands-on learning.*

*Together, the Green Box circulation model and educator trainings constitute an impactful, replicable intervention that advances both access to quality STEM learning and long-term workforce pipeline development. By integrating authentic scientific research, addressing logistical barriers, and embedding professional learning within curriculum deployment, this program illustrates how experiential models can expand equitable participation in STEM education and inspire the next generation of problem-solvers.*

***Keywords:*** *STEM education, curriculum development, educator professional development, experiential learning, accessibility*

## 1. Introduction

Despite increased national and international recognition of STEM education's importance to the global workforce and scientific achievement, access to high-quality and inquiry-based STEM learning remains inconsistent across educational contexts [1, 2]. These challenges are often contributed to difficulty in accessing and implementing grade appropriate STEM learning, stemming from limited resources, capacity, and educator preparedness [1, 3]. In turn, limited engagement with STEM content reduces opportunities for students to engage in authentic scientific inquiry and discover pathways into STEM-related postsecondary education and careers. Research consistently demonstrates that experiential and inquiry-based learning approaches support student engagement, conceptual understanding, and persistence in STEM disciplines [1,3,4, 5]. Learning experiences grounded in real-world problems and authentic scientific practices are associated with improved student motivation and deeper understanding of scientific concepts [4,5]. However, effective implementation of these approaches requires more than access to curricular resources alone; educators must also be supported through professional learning experiences that build instructional confidence and provide practical strategies for classroom integration [6].

The Desert Research Institute's (DRI) STEM Education Program was established to address these systemic barriers through an integrated model that combines research-informed curriculum development with educator professional development [7]. DRI is a global environmental research institute, with over 600 scientists researching global environmental phenomena. Since 2010, DRI's STEM Education program has supported educators and students by leveraging DRI's scientific expertise to create accessible, hands-on STEM learning experiences. This paper describes the structure, implementation, and observed outcomes of this experiential model, with a focus on its scalability, sustainability, and potential for replication across educational contexts.

## 2. Conceptual Framework and Program Rationale

DRI's STEM Education Program is grounded in experiential learning theory and integrated STEM education frameworks that emphasize active engagement, real-world relevance, and interdisciplinary learning. Experiential learning models position students as active participants in the learning process, enabling them to construct understanding through investigation, problem-solving, and reflection. When grounded in authentic scientific research, these approaches can strengthen student engagement and support STEM identity development. Integrated STEM education frameworks further emphasize the application of disciplinary knowledge to real-world challenges, reinforcing connections between science content, societal relevance, and workforce pathways. Embedding authentic research questions and applications within classroom instruction helps students understand how STEM concepts are used beyond the classroom and how they relate to real scientific and societal challenges [1].

As a scientific research institution, DRI conducts applied and fundamental research across atmospheric, earth, and hydrological sciences. This institutional context enables real-world scientists, active research questions, and current scientific data to be integrated directly into curricula. This curricula reflects contemporary scientific practice, allowing students to engage with concepts, tools, and methodologies used by practicing scientists. The content pipeline from research to curriculum strengthens the authenticity of classroom learning experiences. Students are introduced to scientific concepts through real research contexts rather than simulated examples, supporting deeper conceptual understanding and relevance. Embedding active research within classroom instruction also provides opportunities to draw parallels from classroom lessons to real-world applications and career pathways, reinforcing science as an applied and evolving discipline.

Educator capacity is a central component of this conceptual framework and critical to sustaining experiential STEM instruction. Research on professional learning consistently demonstrates that practice-oriented and application-focused professional development is more likely to result in instructional change than isolated exposure to new materials [6,8]. Within the DRI model, educator trainings are designed as stand-alone professional learning experiences that are intentionally aligned to curriculum. While educator training participation is not required to access curriculum materials, the content of each training is structured to support effective classroom implementation of the related curriculum. During trainings, educators engage directly with curricular content, exploring the research informing each curriculum unit, and examining instructional strategies that support inquiry-based learning. This approach supports instructional confidence and reduces uncertainty associated with facilitating open-ended investigations. By addressing both pedagogical practice and classroom readiness, these trainings serve as an accessible entry point for educators seeking to incorporate experiential STEM learning into their instruction.

The conceptual framework guiding this work integrates experiential learning, research-practice partnerships, and systems-level approaches to instructional implementation. Experiential learning theory emphasizes learning through direct engagement, reflection, and application, positioning students as active participants in the learning process. When grounded in authentic research contexts, experiential approaches support deeper conceptual understanding and the development of scientific reasoning and problem-solving skills [1,4]. Research-practice partnerships further inform this framework by emphasizing collaboration among scientists, curriculum developers, and educators. Systems-level thinking underpins the programmatic approach to scalability and sustainability. Rather than focusing on isolated classroom interventions, this model addresses multiple components of the educational ecosystem, including curriculum design, professional learning, and institutional capacity. Together, these elements form a cohesive conceptual framework that supports sustained, high-quality experiential STEM instruction across a wide range of educational settings.

## 3. Program Design

These programs are implemented through a coordinated delivery model that organizes curriculum development, material distribution, and educator support into a single operational system. This section describes how the program is structured and delivered, focusing on the mechanisms that enable consistent classroom implementation at scale. Our delivery model consists of two primary components: reusable curriculum kits and stand-alone educator professional development trainings. These components are intentionally aligned but function independently, allowing educators to engage with one or both elements based on local needs and instructional context. Curriculum kits serve as the primary instructional resource, while professional development provides optional instructional support. This separation ensures broad accessibility while preserving coherence across program offerings.

### *3.1 Program Design: Green Box*

DRI's Green Box Program serves as the core curriculum delivery mechanism within the DRI experiential STEM model [8]. Green Boxes are reusable, self-contained curriculum kits designed to support three to four weeks of classroom instruction. Each kit is aligned with national science standards and grounded in active environmental research conducted by DRI scientists, ensuring both scientific accuracy and relevance. Since 2010, the Green Box Program has expanded to include more than 200 curriculum kits covering over 30 distinct STEM topic areas. Topics span earth, atmospheric, and hydrological sciences and are designed to support instruction across PreK–12 grade levels. Curriculum materials are intentionally modular, allowing educators to adapt lessons to meet local instructional goals and classroom constraints without compromising core learning objectives. This flexibility supports implementation across a wide range of educational settings, including elementary, middle, and high school classrooms. By grounding curriculum in active research, the Green Box program ensures that instructional content remains current and connected to real-world scientific practice.

Each Green Box contains all materials, equipment, and consumables required for classroom implementation, eliminating the need for educators or schools to purchase specialized resources. This comprehensive design reduces preparation time and minimizes logistical challenges associated with hands-on instruction. Educators reserve kits for an academic quarter, after which they are returned to DRI for evaluation, restocking, and quality control. Kits are then redistributed to new classrooms, enabling repeated use and maximizing instructional impact. This circulation model supports long-term sustainability while maximizing reach and cost efficiency by allowing a finite set of resources engage large quantities of educators and students across time and locations.

Career profiles and research context are embedded within each Green Box to connect classroom learning to real-world STEM applications. These components introduce students to a range of scientific roles and pathways, highlighting how classroom concepts relate to ongoing research and professional practice. Career connections are intentionally integrated into instructional activities rather than presented as standalone content, reinforcing relevance throughout the learning experience. This design supports student understanding of science as a dynamic and applied field while helping educators frame STEM learning within broader societal and workforce contexts. Together, these elements position the Green Box Program as a comprehensive, sustainable approach to delivering experiential STEM education grounded in authentic research.

### *3.2 Program Design: Educator Professional Development Model*

Educator professional development is intentionally integrated with Green Box curriculum deployment to support effective classroom implementation. Professional development trainings are designed to build educator confidence with inquiry-based instructional strategies and provide opportunities for hands-on engagement with curriculum materials. Training sessions emphasize active participation, classroom implementation planning, and discussion of instructional adaptations for varied learning environments. Educators experience curriculum activities from a learner's perspective, allowing them to anticipate student questions, identify potential challenges, and explore facilitation strategies. This experiential format supports instructional confidence and helps educators visualize how lessons will function within their own instructional settings. Furthermore, each professional development training is grounded in the same research themes and scientific content reflected in the Green Box curriculum. Educators are introduced to the underlying research informing each curriculum unit and engage with the scientific questions, data, and methodologies that shape instructional activities. This approach allows educators to deepen their content knowledge while gaining insight into how research is translated into classroom learning experiences. By situating professional learning within authentic scientific contexts, these trainings reinforce the connection between classroom instruction and real-world research practice.

On average, the program supports professional development for more than 600 educators annually. Participants represent a wide range of instructional backgrounds, content areas, and experience levels. Training facilitation is structured to accommodate this variation by offering scaffolded instruction and opportunities for deeper engagement. Educators consistently report increased confidence in facilitating hands-on learning, improved understanding of how to connect classroom content to real-world science, and greater readiness to implement inquiry-based instructional strategies. Educator Professional Development Trainings provide educators with the instructional context, confidence, and the practical strategies needed to implement research-based curriculum effectively. This alignment between curriculum and professional learning strengthens instructional consistency while preserving flexibility for educators and schools. As a result, this professional development model supports sustained, high-quality experiential STEM learning across a wide range of educational settings.

**4. Implementation and Observed Outcomes**

Implementation of the Green Box Program occurs within a complex educational landscape shaped by local capacity, instructional priorities, and varying levels of prior exposure to experiential STEM instruction. Program staff work closely with educators and school partners to align curriculum with local instructional goals, academic calendars, and classroom constraints. This flexibility allows the model to function effectively across varied settings while maintaining consistency in instructional quality. From an educator perspective, access to fully resourced curriculum kits reduces perceived risk associated with inquiry-based instruction. Educators report greater willingness to implement hands-on lessons when logistical barriers are minimized and instructional support is readily available. This reduction in instructional burden supports more consistent adoption of experiential learning approaches. Classroom implementation data, while primarily qualitative, consistently indicates that hands-on engagement supports improved student participation and scientific discourse. Educators report that students demonstrate increased willingness to ask questions, collaborate with peers, and engage in problem-solving activities when lessons are connected to authentic research applications.

Observed outcomes related to educator professional development reflect changes in instructional confidence, classroom readiness, and approaches to experiential STEM instruction. Educators who participate in these trainings report increased familiarity with inquiry-based instructional strategies and greater comfort facilitating hands-on investigations. Feedback indicates that trainings support educators in anticipating classroom challenges, managing materials effectively, and pacing multi-day experiential lessons. Educators also report improved ability to contextualize scientific concepts using real-world research examples, reinforcing connections between curriculum content and contemporary scientific practice. These outcomes are particularly evident in educators' willingness to implement open-ended investigations and adapt instructional strategies to support student inquiry. Participation in professional development is associated with more consistent use of Green Box curriculum and increased likelihood of repeated program engagement. From an implementation perspective, educator trainings function as a mechanism for strengthening instructional fidelity while preserving flexibility in classroom application. Collectively, these outcomes suggest that aligned educator professional development supports sustained and effective use of experiential STEM curriculum across grade levels and instructional contexts.

**5. Discussion**

DRI's STEM Education Program illustrates how research institutions can translate scientific expertise into sustained classroom impact through intentional program design. Rather than relying on isolated interventions, this program integrates curriculum, professional learning, and operational infrastructure into a coordinated delivery system. This alignment allows experiential STEM instruction to be implemented consistently across classrooms while remaining adaptable to local instructional contexts. A defining feature of this work is the intentional separation and alignment of its core components. Curriculum kits and educator professional development trainings function independently, allowing educators to engage with one or both elements based on individual needs. At the same time, shared scientific context and instructional goals ensure coherence across program offerings. This structure supports broad participation

without requiring uniform pathways, an approach that may be particularly relevant for institutions seeking to scale educational outreach without imposing rigid participation requirements.
At a systems level, this program demonstrates the value of research–education partnerships that prioritize operational feasibility alongside instructional quality. Collaboration among scientists, curriculum developers, and education specialists supports alignment between research content and classroom practice. Continuous feedback from educators informs curriculum refinement and professional development design, creating an iterative improvement cycle that strengthens program effectiveness. This feedback-driven approach supports responsiveness to changing instructional needs and evolving scientific research. The broader implications of this work extend to institutions seeking to expand their role in STEM education beyond traditional outreach activities. By embedding education programs within existing research infrastructure, institutions can leverage scientific expertise, facilities, and personnel to support meaningful classroom engagement. DRI's STEM Education Program model suggests that sustained impact is more likely when educational initiatives are designed as integrated systems rather than standalone projects.
While this program's outcomes are primarily practitioner-informed, the consistency of observed implementation patterns and educator feedback provides insight into how experiential STEM models function at scale. Future work may include more formalized evaluation approaches to document instructional and student-level outcomes over time. Even in the absence of experimental data, the program offers a practical example of how research institutions can design, deliver, and sustain experiential STEM education across educational settings.

## 6. Conclusion

Expanding access to high-quality and experiential STEM education requires more than well-designed curriculum or isolated professional learning opportunities. Effective programs are built as systems that align instructional resources, educator support, and operational infrastructure in ways that are practical, sustainable, and responsive to classroom realities. When these elements are designed to work together, experiential learning becomes feasible at scale rather than limited to individual classrooms or short-term initiatives. The model described in this paper illustrates how research-informed curriculum, aligned professional learning, and intentional delivery structures can support consistent implementation across varied educational contexts. By emphasizing adaptability, reuse, and continuous refinement, programs can extend their reach while maintaining instructional quality. For practitioners and institutions seeking to strengthen experiential STEM instruction, the key takeaway is not the replication of a single program, but the application of a systems-oriented approach that integrates research, practice, and operational design. Such approaches offer a durable path for sustaining meaningful STEM learning experiences over time.

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