SAGES: Science for All Generations through Environmental Stewardship

The Role of Environmental Stewardship in SAGES

What is SAGES?
SAGES uses the natural world as a context for learning and engages students in science and engineering practices based on research from the *Framework for K-12 Science Education*. The SAGES model includes a curated collection of 3-dimensional Next Generation science lessons, corresponding supplies and resources, professional development for teachers, and assessment tools that can be used for competency-based learning or differentiated instruction. Every science topic offers an opportunity for students to participate in research, an inquiry investigation, problem-solving, and implementation of an environmental stewardship project.

What is environmental stewardship?
Environmental stewardship is a type of project-based learning that gives students a chance to solve real problems and make a difference in the world. It is characterized by experiential learning based in a specific community and culture to provide students with relevance and context for deeper understanding of the core ideas in science, as well as measurable benefits to the environment.

Why environmental stewardship?
SAGES features environmental stewardship activities for two reasons: 1) to provide students with a systemic, relevant, experiential way to understand science concepts; and 2) to empower young people to think critically, solve problems, and take action in their schoolyards and communities to protect earth's resources.

Essentials of Environmental Stewardship

Problem definition
Identification / authentication of need

Research
- Literature review
- Meta-analysis of previous research (methods and findings)

Inquiry
- Extended student-led investigation
- Data collection and analysis
- Citizen Science (data reporting)
- Critical thinking & sense-making

Stewardship
Iterative Design Process
- Brainstorming solutions
- Collaborative planning
- Creative problem-solving
- Deciding on project approach
- Prototype or Implementation
- Redesign, as necessary

Evaluation and Reflection
- Benefits to the Environment
- Student academic gains
- Changes in attitudes, behaviors
- Communication of results

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Examples of Environmental Stewardship Projects that Students Have Designed Based on Local Needs

Habitat Restoration on Schoolyards and in Communities

- Removal of non-native, invasive species
- Planting native plant species
- Creating pollinator habitats for bees, butterflies
- Restoring missing elements of wildlife habitat (water, shelter, food, places to raise young)
- Organic practices to reduce pesticides and herbicides
- Creating artificial habitats as necessary

Water Quality Monitoring and Improvement

- Water quality testing and monitoring
- Water pollution prevention or mitigation
  - Storm drain marking to reduce dumping
  - Stream bank stabilization to reduce siltation
  - Stream shading (tree planting) to restore cooler water temperatures and habitats
  - Reduction of carbon releases to limit ocean acidification and impacts on marine life
  - Planting wetlands, bio-swales, or rain gardens to filter the first flush and slow flow
  - Replacing turf with native ground covers
  - Reducing use of disposable plastics
- Water conservation methods

Bioremediation

- Planting hyper-accumulating plants to remove toxins
- Inoculating straw bales or wood chips with fungi to absorb and digest oil from run-off

Climate resilience

- Promoting use of renewable energy to reduce GHGs
- Reducing energy consumption

Species Protection

- Biodiversity inventory or species inventory
- Raising / releasing threatened or endangered species

Waste Reduction

- Recycling, repurposing to divert waste from landfills
- Reduction of wasteful packaging and product use
- Composting, vermiculture, and soil conservation

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Implementation Plan for SAGES including Environmental Stewardship

Phase 1 Development of Model
CPF collaborates with curriculum coordinators and exemplary teachers to create and test the SAGES model

- Design backwards from standards to identify existing exemplary lessons
  - Review open-source curriculum
  - Modify lessons to engage kids in 3-dimensional science practices
  - Analyze gaps
  - Create new content as needed
  - Integrate environ. stewardship
- Create multiple opportunities for success thru competency-based or differentiated learning opportunities
  - Digital badges symbolize mastery
  - Web platform for ease access to open-source, curated lessons
- Develop supply kits for lessons & projects
  - Fulfillment thru Pratt Plus
  - Distribute thru Donors Choose
- Increase teacher capacity to facilitate student-led envir. stewardship projects
  - 200 hour science endorsement
  - Outdoor classroom mgmt. skills
- Design evaluation plan and tools
  - Lawson Test Scientific Thinking
  - Performance based assessment
  - Changes in attitudes, behaviors
  - Quantify environmental benefits

Phase 2 Implementation

- Identify similar classrooms for field-testing and comparison purposes in GA
- Field test SAGES model, stewardship
- Analyze feedback and results
- Redesign as necessary

Phase 3 Replication

- Field-test in NGSS and non-NGSS states
- Adapt locally, as needed
- Record hands-on webinars, create kits

Phase 4 Scaling Up

SAGES Research Questions about Environmental Stewardship

Background: Children Gain a Deeper Understanding of the Core Ideas of Science by Engaging in Problem-Solving with Science and Engineering Practices when Developmentally Appropriate. Project-based learning is more effective that rote memorization of facts in science education, particularly for some underserved groups of students. (NRC, 2011. *Framework for K-12 Science Education*)

Research Question #1
Can authentic environmental stewardship projects that engage children in relevant, student-directed problem solving be a) more engaging and inclusive of traditionally-underserved groups of children and b) more effective in promoting a deeper understanding of science concepts and critical thinking than contrived project-based learning (i.e. building pointless spaghetti and marshmallow towers)?

Background: Children Connect to Nature through Wild Play
Environmentally-friendly attitudes and behaviors in adulthood are correlated to childhood experiences of wild play but *not* to environmental education in a classroom setting. (Wells, 2006. *Nature and the Life Course*)

Research Question #2
For a generation of digital natives with little or no time spent outdoors, can field investigations and exploration during inquiry-based science substitute for missing wild play experiences in childhood, in terms of connecting children to nature; instilling wonder; and providing motivation for adult environmentalism?

Background: Studying the Environment in School can make children feel Overwhelmed and Disengaged (Sobel, 1998. *Ecophobia*; Chawla, 2006. *Learning to Love Nature*)

Research Question #3
Can engaging children in bite-sized, local environmental stewardship projects, characterized by authentic real-world problem-solving and student-directed solutions, reduce disengagement, increase self-efficacy and empower children to make a difference in the world?

SAGES Logic Model			
OUTPUTS	**OUTCOMES**		
Short Term	**Short Term**	**Medium Term**	**Long Term**
Establishing **partnerships** with school districts and **recruitment of teachers** for field testing and replication of SAGES model	Increased awareness of the **potential for environmental ed** to bridge separate disciplines of science	Growing perception of the **environment as an effective context for teaching** all the core ideas in science, among teachers, administrators and community	**Establishment of sustainable science education programs** with environmental stewardship as key instructional strategy
Delivering **professional development** workshops on instructional strategies and Next Gen science and engineering practices	Increased teacher **willingness to take class outdoors** for inquiry investigations, engineering challenges and environmental stewardship	Greater student **exposure to the outdoors thru inquiry**; which fosters a sense of wonder and discovery, cultivates curiosity, and creates an affinity for nature which is necessary in childhood	. . . . for eventual **adoption of environmental friendly attitudes and behaviors as adults**
Continuing professional development via **hybrid hands-on distance learning** and mentoring methods, with additional science content introduced monthly	**Fidelity to model** and curriculum materials and instructional strategies is improved with continuing contact. Hybrid distance learning model has potential to provide **effective teacher training in rural states** with limited internet	Increased teacher capacity to engage students in **authentic integrated science, technology, engineering and math** leads to increased student academic success and deeper understanding of the core ideas in science	More interest by students in environmental science and in **STEM careers or college majors, especially among under-represented minorities** who might otherwise not have realized their aptitudes and interests
Distribution of NGSS-aligned **curriculum supplies** and stewardship project kits containing lesson plans, protocols, and materials based on best practices in environmental ed	Availability of supplies make **outdoor learning opportunities more feasible and varied**, including citizen science, data collection, investigative projects, engineering challenges, and stewardship	Students learn core science concepts by **acting as scientists** (doing science instead of reading about it)	Students are **better prepared for citizenship** and for playing a role in policy development regarding environmental issues because of they have honed critical thinking skills, logic, and argumentation from evidence
Award **sub-grants** for custom, student-designed, place-based environmental stewardship projects in SAGES field testing locations.	All sub-grantees will be required to collect data that measures **tangible benefits to the environment.**	Student engagement in project-based learning and environmental stewardship is **empowering,** and give students the confidence that they can make a difference	Students act to **solve environmental problems,** adopt attitudes and behaviors that reduce adverse human impacts, and improve environmental quality
Documentation, data collection and evaluation of student and teacher performance	Feedback provides valuable information for **re-tooling of SAGES model.** Films and lessons for sub-grantee's projects will make them **m easily replicable.**	More effective learning experiences promote **student academic success, environmental literacy and teacher self-efficacy**	Replicability of SAGES model contributes to more **effective integration of Next Gen Science, STEM + environmental stewardship**