STELLA: Co-Creating Open-Source Remote Sensing Tools for STEM Workforce Development

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Introduction

STELLA transforms students into engineers and scientists with hands-on environmental monitoring technology. These affordable ($200) NASA-inspired instruments create direct pathways from classroom curiosity to careers in science, technology, and engineering through real-world, authentic STEM problem-solving experiences.

The Access Problem

- Traditional instruments cost thousands, which many students and classrooms can't afford
- No hands-on engineering experience
- Limited hands-on training with scientific instruments
- Students lack practical experience building measurement systems
- Gap between classroom theory and real-world applications

Goals

- Develop Future STEM Workforce
- Enrich NASA Mission Connections
- Foster Technical Skill Building
- Bridge Theory & Practice
- Create Accessible Technology
- Support Multiple Pathways
- Enable Relevant Science

Technical Skills Development

Multi-Level Technical Skill Pathway

STELLA offers a step-by-step journey from basic to advanced technical mastery:

Level 1: Data Collection
Students use pre-assembled STELLA-Q2 instruments to gather spectral data

Level 2: Data Analysis
Learners interpret spectral patterns, calculate vegetation indices, and correlate measurements with environmental conditions.

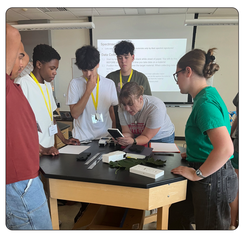
Level 3: Instrument Assembly
Students construct STELLA devices through cable connections and component placement

Level 4: Hardware & Software Customization
Advanced users write code, integrate new sensors, and design 3D-printed enclosures.

Level 5: Independent Research
Students conduct authentic environmental investigations using self-built instruments

This pathway ensures appropriate skill development for all learning levels.

Workforce Development Outcomes

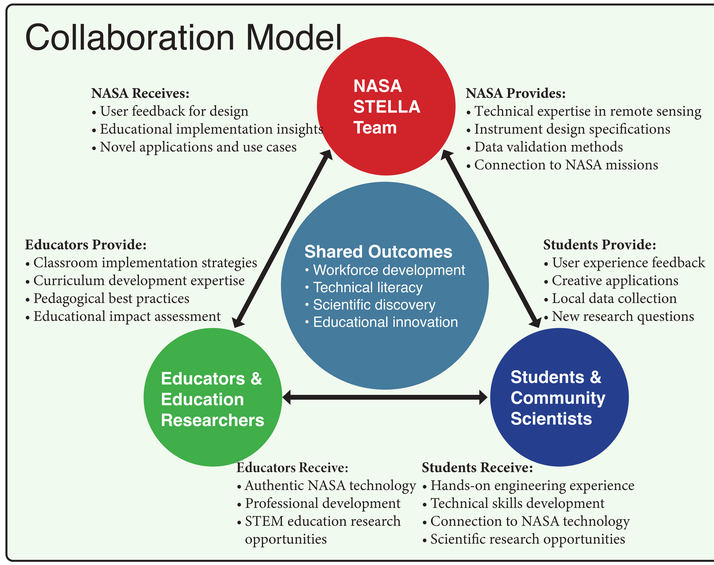


Real-World Example:
University of Wisconsin-Madison interns Inna Shapovalenko and Alexa Matson redesigned STELLA-Q2 cases for increased battery capacity, developed educational activities, and created websites for data analysis—the same skills needed in professional scientific instrument development (Shapovalenko, 2024).

Real-World Example:
STEM educators from Maryland and Virginia built their own STELLA spectrometers and conducted hands-on investigations into plant analysis, surface properties, and environmental monitoring. Participants left with instruments for classroom use and the confidence to integrate NASA remote sensing concepts into their teaching.

Technical Skills Developed	Professional Applications
• Instrument calibration • Field measurement protocols • Metadata documentation	• Environmental scientist • Agricultural technician • Field researcher
• Spectral signature interpretation • Spectral Indices calculation • Statistical analysis • Python/R programming	• Remote sensing analyst • GIS specialist • Data scientist
• Electronics troubleshooting • Component integration • Testing procedures • Technical documentation	• Instrument technician • Laboratory specialist • Field equipment manager
• 3D design & printing • Microcontroller programming • Sensor integration • UI/UX development	• Engineering technologist • Instrument developer • Scientific programmer
• Experimental design • Data collection planning • Results communication • Project management	• Research scientist • Environmental consultan • Project leader

Collaboration Model



Real World Collaboration Model Example

COASTWISE, led by Dr. Nick Barbi and Timothy Childers, engages high school students in wetland research using STELLA spectrometers and drone imaging, developing workforce skills while connecting local studies with NASA **Landsat** technology.

Dr. Nick Barbi and Timothy Childers' team provided STELLA-Q2 feedback through student presentations. NASA engineer Paul Mirel created an engineering failure report, leading to instrument improvements.

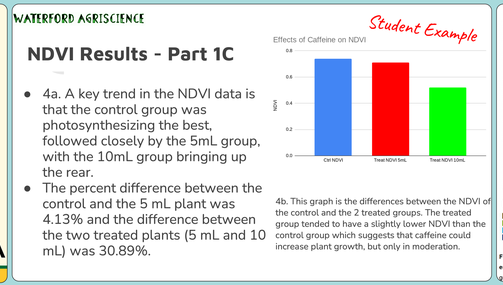
When COASTWISE asked about reflectance data comparisons, the STELLA team introduced them to Landsat and later connected them to NASA's **PACE** satellite for algal bloom studies—demonstrating how collaboration expands scientific applications.

Data Collection & Analysis

"Being a part of the data collection is I think, a really important part of increasing their confidence with looking at data like this." - Tyler Bland, McCall Graduate Student (Eitel, 2024)

STELLA supports data collection and analysis at all educational levels, building progressively sophisticated skills from basic measurement techniques to advanced scientific applications. Students develop authentic data literacy by collecting, processing, and interpreting their own measurements—skills directly transferable to STEM careers.

Karen Karker at the SUNY College of Environmental Science and Forestry, demonstrated how STELLA effectively bridges complex scientific concepts with engaging, visual demonstrations for K-12 education. (Karker, 2024)



Dr. Craig Kohn's high school students investigated how different growing conditions affect radish health, using NDVI measurements to quantify plant stress responses and visualize results. (Kohn, 2025)

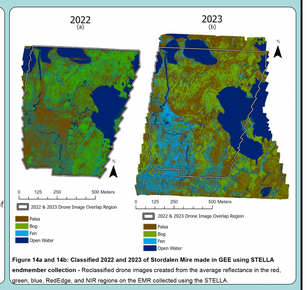
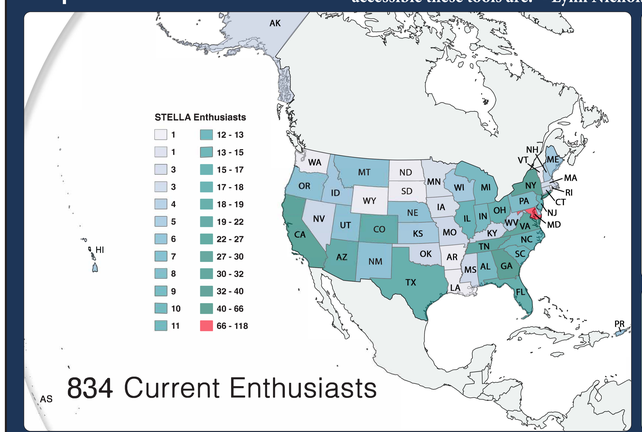


Figure 14a and 14b: Classified 2022 and 2023 of Stordalen Mire made in GEE using STELLA endmember collection - Reclassified drone images created from the average reflectance in the red, green, blue, RedEdge, and NIR regions on the EMR collected using the STELLA.

Bianca Cilento's master's research demonstrated STELLA's scientific field spectroscopy capabilities.. (Cilento, 2024)

Impact & Resources

"Incorporating handheld spectrometers and microcontrollers into teaching in an organic and meaningful way just reiterates how accessible these tools are." - Lynn Nichols, Gilman School PK-12 Director of Education Technology (Taylor & Nichols, 2025)



834 Current Enthusiasts

834+ STELLA Enthusiasts Nationwide
12+ Countries Worldwide

From Alaska to American Samoa, Finland to South Korea—STELLA connects scientists, educators, engineers, makers, farmers and more, in a growing international community of practice.

25 New NASA Technologies

Coming to the STELLA family—specialized liquid analysis capabilities, enhanced environmental monitoring systems, water-compatible instrumentation, advanced atmospheric sensing technology, networked field deployment solutions and extended spectral range options.

Available Resources

STELLA Website
science.gsfc.nasa.gov/stella

STELLA Community Forum
github.com/STELLA-Landsat/STELLA/discussions

Special thanks to our educational partners and the growing community of STELLA users worldwide who continue to expand the project's applications and impact.

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