Enhancing 4-H Student Engagement and Environmental Awareness through Micro:bit-Based: Weather Stations and Sensor Projects

Bayity Kwabena[1]; Yaguang Zhang[2]; Bruce J Erickson[3]

[1] Kwabena Bayity is a Graduate Student in the Department of Agricultural Sciences Education & Communication at Purdue University,
Kbayity@purdue.edu
https://orcid.org/0009-0004-4952-2632
[2] Yaguang Zhang is a Clinical Assistant Professor in the Department of Agricultural & Biological Engineering & Department of Agricultural Sciences Education & Communication at Purdue University
ygzhang@purdue.edu
https://yaguangzhang.github.io/
[3] Bruce Erickson is a Clinical Professor of Digital Agriculture & Director, Agronomy e-Learning at the Department of Agronomy at Purdue University,
berickso@purdue.edu
https://ag.purdue.edu/department/agry/directory.html#/berickso

student or faculty lead project.

Enhancing 4-H Student Engagement and Environmental Awareness through Micro:bit-Based: Weather Stations and Sensor Projects

Introduction/Need for innovation or idea: Communities worldwide are experiencing adverse weather conditions such as floods, wildfires, and droughts, and the United States is no exception, with states like Florida, California, and Iowa facing increasingly erratic weather that disrupts agriculture and daily life (Cain, 2023; French, 2020). These realities highlight the need to raise climate awareness among youth, particularly through programs like 4-H, which prepare students to become informed and resilient leaders (Sabra & Mohammed Abdo Al-Moaz, 2022; Schreiner et al., 2005). In Indiana, where agriculture plays a central role in the economy and community life, equipping youth with the knowledge and skills to understand and respond to climate challenges is especially urgent. Yet many climate education programs remain heavily theoretical and fail to integrate hands-on, technology-based experiences that connect science learning to real-world issues. Kolb's (1984) Experiential Learning Theory emphasizes that transformative learning occurs when students actively engage, reflect, and apply knowledge. This workshop introduced Purdue 4-H Academy students to innovative, technology-driven projects such as building weather stations and soil moisture systems using micro:bit and sensors that move beyond theory to experiential, problem-solving learning.

How it works/methodology/program phases/steps: This was a hands-on, structured workshop for 4-H Academy students at Purdue, where participants engaged in team-based activities across two sessions in two days for 3-hours each. While students entered with a range of coding and technical skills from experienced to beginner, their specific prior knowledge of weather concepts was not assessed. This technical background allowed them to engage quickly with the tools for data collection, while the workshop itself introduced the practical application of these tools for understanding weather science. On the first day, students worked in groups to design and build weather stations using micro:bits, compatible sensors, and prototyping materials. These stations were programmed to detect, record, and display environmental data, including temperature, humidity, and light intensity. On the second day, students also constructed mini structures to house the micro:bit and sensors, simulating practical applications in homes, schools, and local communities. Participants built automatic moisture detection systems, re-echoing their understanding of sensor-based technologies for measuring weather data. Using a detailed manual as a guide, students explored these activities step by step and were encouraged to try additional projects outlined in the manual independently. The structured approach ensured that all participants could follow along while still allowing space for creativity, teamwork, and problem-solving.

Results to date/implications: The workshop successfully bridged the gap between abstract coding concepts and their tangible application in environmental science. Students overwhelmingly demonstrated a newfound understanding of how the data they collect such as temperature and humidity forms the foundation for tracking weather patterns and community disaster preparedness. In fact, 100% of participants agreed the workshop showed how coding and electronics apply to everyday life, with 78% strongly agreeing they now understand how weather technology helps communities prepare for disasters. This hands-on experience had a significant impact on student engagement and career interests. Most students entered with prior coding experience and found the Micro:bit activities highly engaging. This direct application sparked a strong interest in STEM fields, with 90% of students expressing curiosity in careers related to climate, environmental technology, and emergency readiness. As one student

student or faculty lead project.

reflected, *"This workshop helped me understand how coding and electronics can be used in science or everyday life."* Feedback pointed towards a desire for even deeper learning, with students suggesting more hands-on coding time and clearer instructions, indicating a cohort ready for more advanced, interactive challenges.

Future plans/advice to others: Our future plans focus on deepening the connection between data collection and weather pattern recognition. We will integrate more advanced sensors for metrics like soil moisture and air quality, and crucially, link weather stations to online dashboards. This will allow students to visualize data over time, identify trends, and understand how different environmental metrics interact to form weather patterns. Deploying these systems in real-world contexts like school gardens will provide essential practical context. To ensure wider impact, we will develop a train-the-trainer model to equip more educators with the skills to deliver this workshop. For others running similar programs, we advise starting with simple, step-by-step projects while consistently framing activities around real-world issues. Encouraging students to find the "story" in their data asking what the numbers tell us about our environment transforms a technical exercise into meaningful scientific inquiry and sustains engagement in STEM.

Costs/resources needed: The workshop utilized a cost-effective mix of components, all of which were essential. Lower-cost items like spray bottles and connector cables were used alongside core, specialized components such as micro:bit boards, environmental sensors, and OLED displays. This strategy-maintained accessibility without compromising the hands-on learning objectives. For future growth, the primary costs will transition from initial setup to scaling and enhancement. This includes purchasing additional core kits to accommodate more students, investing in advanced sensors and software for data dashboards, and funding the development of training materials and facilitator stipends to support a sustainable train-the-trainer expansion model.

References:

Cain, B. E. (2023). *Under fire and under water: Wildfire, flooding, and the fight for climate resilience in the American West* (First edition). University of Oklahoma Press.

French, C. (2020). *America on Fire: Climate Change, Wildfires & Insuring Natural Catastrophes*. *54*.

Guler, S. D., Sotelo, S., & Iwabuchi, M. (2022). Tekniverse: Towards a connected future for sensors, education, and action: Fostering Environmental Literacy with IoT and Physical Computing. *Interaction Design and Children*, 583–589. https://doi.org/10.1145/3501712.3535291

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Upper Saddle River, NJ: Prentice Hall.

Sabra, Prof. Z., & Mohammed Abdo Al-Moaz, Dr. E. (2022). Awareness of Climate Change— The role of art, education and culture in raising awareness of climate change. *International Journal of Education and Learning Research*, *5*(1), 48–70. https://doi.org/10.21608/ijelr.2023.215523.1005

Schreiner, C., Henriksen, E. K., & Kirkeby Hansen, P. J. (2005). Climate Education: Empowering Today's Youth to Meet Tomorrow's Challenges. *Studies in Science Education*, *41*(1), 3–49. https://doi.org/10.1080/03057260508560213