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Hydroponics as a medium for teaching STEM to middle school youth

AT A GLANCE

We took hydroponics to Weiser Middle School. Students learned to build small hydroponics systems while developing math, engineering and horticulture skills.

The Situation

University of Idaho Extension in Washington County partnered with Weiser School District to provide afterschool enrichment as part of the Better Educated Students of Tomorrow (BEST) afterschool program at Weiser Middle School. The time slot for the enrichment program was limited to between 35 and 40 minutes. This led to time constraints that made it difficult to provide meaningful STEM activities that held the attention and challenged this age group. Many of the youth seemed uncomfortable with STEM topics and struggled noticeably with mathematics.

Our Response

To better engage the students and help them grow more accustomed to the use of applied STEM principles, we designed a STEM series on hydroponic horticulture, which is the production of plants without soil. We researched some simple classroom designs, adapted a system design for locally available parts and purchased the materials for two units costing less than $100 apiece (Table 1). We developed seven curriculum modules to fit the 35 to 40-minute time blocks, including: What is hydroponics? — Growing plants without soil; pumps, pump output and measuring water flow; pipe cutter handling and tool safety; framing and cutting to size, Part 1; Framing and cutting to size, Part 2; Drill and tap, drilling for nozzle assembly; system assembly and plant installation. Students built the two simple, table-top hydroponic systems over the course of the semester in seven afterschool enrichment sessions. Students were introduced to a new topic, design methods or assembly technique each session. Students were taught basic plant needs and the science of growing plants without soil via hydroponics. Students learned to determine and measure basin, pipe, and tool sizes and computed pump outputs to apply mathematics to their project. Elementary engineering principles were also introduced via pump selection and hydraulic movement. Throughout the process students were able to learn to safely use several basic tools, including power tools. Students began the semester-long

Weiser Middle School youth assemble one of two table-top hydroponic systems.

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project by starting their own basil from seed to have transplants by the end of the project. Using a basic template, they then designed the systems; cut, fit and retrofitted parts; and assembled them before finally installing their basil. Nineteen students participated. We conducted pre- and post-program assessments using simple questions about plant needs and requirements to gage changes in student knowledge.

Table 1. Estimated costs for materials for one table-top hydroponic system. *Materials not source through local hardware.

Item	Count	Unit	Price
Pump	1		39.98
Heavy duty tote	1	27 gal	14.99
Silicon tubing	1 ft @ .79	5/8" ID	.79
Clamps	2 @ 1.79	3/4"	3.58
PVC	1 ct. @ 3.59	10 ft 3/4"	3.59
PVC elbows	10 ct.	3/4"	3.99
PVC tee	2 ct. @ .79	3/4"	1.58
Adapter PVC tee	1 ct. @ .99	3/4"	.99
Barbed tubing fitting	1 ct. @ 1.49	5/8" to 3/4"	1.49
Misters	20 ct. @ 4.99	360°	4.99
Misters	20 ct. @ 4.99	180°	4.99
Net pots*	50 ct.	2"	6.95
Neoprene collars*	50 ct.	2"	11.99
Total			$99.90

Program Outcomes

Teaching hydroponics as a curriculum series for after-school enrichment proved an excellent tool for providing quality STEM education to middle school students in short sessions. The seven modules provided a step-by-step enrichment approach so that students could build on acquired knowledge. When the project began, not one student had heard of hydroponics. By the end of the project, 90% of the students could define it without prompting. It also helped students apply STEM principles in real-time. Sixty-three percent of students in the program felt more comfortable applying mathematics to solve applied problems following completion of the program. Ninety-five percent of the students felt more comfortable using simple tools for building the table-top systems and recognized the importance of applied mathematics to take measurements and select tools, equipment and system parts.

Student knowledge of plant science was also improved through the program. Knowledge of basic plant requirements (sunlight, water and nutrients) nearly quadrupled, with a 380% increase, over the duration of the program (Figure 1).

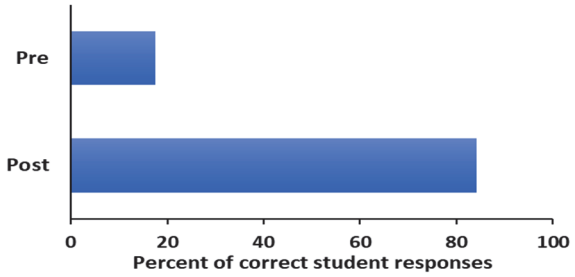

Figure 1. Percentage of youth correctly responding to questions about basic plant needs pre- and post-program.

Hydroponics curriculum is an ideal vehicle for modular STEM programming with middle school youth. By incorporating biological and mathematical principles with technology, it not only appeals to sixth through eighth grade youth but also provides long-term engagement for short-session programs like BEST.

Extending the program for successive modules addressing hydroponic crop production, harvest and crop end use could provide greater STEM training opportunities and additional life skills in agriculture, nutrition and food preparation.

FOR MORE INFORMATION

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