



Using Aquaponics for STEM Education

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There is a growing push in K12 education to develop experiential learning activities and curricula to educate students in the STEM (Science, Technology, Engineering, and Math) fields. Experiential learning refers to the teaching practice of having students apply their knowledge and skills to problem-solving and projects. Research has shown that the integration of knowledge into applied projects increases interest, experience, and enthusiasm for science in children. Here in New Mexico, and in most schools throughout the country, the first thing that comes to mind when you think of STEM education is robotics and computer science. But this is a narrow view of how STEM fields can be taught in an immersive, hands-on environment. Aquaponics offers the opportunity to deliver a STEM curriculum that includes a wide range of subjects, including agricultural sciences, ecology, math, engineering, chemistry, and more. Aquaponics is a natural fit for STEM education and experiential learning.

What is Aquaponics?

Aquaponics is a sustainable, efficient food production system that combines Hydroponics (the cultivation of plants in a soilless medium) with Aquaculture (raising fish or other aquatic organisms) in a closed, recirculating system. It is currently one of the fastest growing segments of aquaculture. Recirculating aquaculture systems (RAS), such as aquaponics systems, are very well suited to New Mexico's climate because they use substantially less water than traditional soil based agricultural systems (90 % less). Aquaponics is an integrated and balanced system that uses the waste from the fish farming component as the nutrient source to grow the plants. As a result, plants serve as a natural filtration system to clean the water, and the plants receive a natural

nutrient source free of commercial fertilizers. Other benefits include:

1. no weeding, tilling, or soil-borne diseases
2. plants grow as much as four times faster than soil-grown plants
3. more can be grown with less space
4. No farmland required

For more information on aquaponics refer to the following extension publications listed at the end of this article.

Opportunities to use Aquaponics to teach STEM

Operating an aquaponics system incorporates knowledge from a wide variety of subjects, including agriculture, biology, engineering, nutrition, chemistry, and technology. It offers hands-on learning, flexibility, and integrates fun into science, addressing STEM disciplines as well as food concepts. For example, students can study the fish, plants, and nitrifying bacteria that all interact in a living ecosystem. Students can perform water quality tests, and measure and monitor growth rates in fish and plants. In addition to STEM disciplines, other areas of study connected to aquaponics include economics, marketing, and nutrition.

Aquaponics systems can be as simple as a single small aquarium and plant tank or as complex as a multi-unit production system. An aquaponics system that is suitable for a classroom is simple and inexpensive to build. There are numerous manuals and simple plans available that provide step by step instructions on how to build simple aquaponics systems suitable for school instruction (refer to the following link for an example: <https://www.aces.edu/wp-content/uploads/2021/02/ANR-2711-TabletopAquaponics021821L-A.pdf>). In addition to serving as an educational tool, aquaponics projects teach life skills, can encourage cooperative learning, and bring students of diverse backgrounds and skill sets together. Some schools with aquaponics systems sell fish and plants to generate funds for their program, and others incorporate their fish and vegetables into their own culinary programs. This can also teach students business skills, such as sales, marketing, and entrepreneurship.

For those who are less comfortable with their carpentry and building skills, there are also a growing number of small-scale systems built specifically for educational purposes that can be purchased at reasonable costs from reputable companies such as Colorado Aquaponics (<http://www.coloradoaquaponics.com>) and Symbiotic Aquaponic (<http://www.symbioticaquaponic.com>) in Oklahoma. Additionally, there are grants available that provide funds to schools to support Aquaponics/aquaculture-related STEM education initiatives. More information can be found at the following link: <https://www.aquaponicsusa.com/education/where-to-get-an-aquaponics-grant.html>. There are also non-profit organizations such as 100 Gardens (<https://www.100gardens.org>) that partner with schools and other organizations to help educate students about

the benefits of aquaponics. Through this partnership schools gain a state-of-the-art aquaponics system and tools needed to teach students about aquaponics.

There are also resources available that provide school curricula for K12 complete with lesson plans that vary in complexity depending on the grade of the students. Kenneth R. Thompson, Kentucky State University's State Specialist for 4H STEM/ Youth development, has just released a comprehensive aquaculture teacher manual which provides a detailed framework on how to incorporate aquaponics project-based instruction as a teaching and learning tool for high school students

(https://gofile.me/6cBnf/0ERDbRppr?fbclid=IwAR2FS0JXKTxDy4CeHc6iGNI_Gjv0zrLhWfI3cKjlufabzo48HzFy2Z4MRpE)

For more information on how schools can learn about incorporating aquaponics into their classrooms and their STEM education curriculum, refer to the list of references provided below. Here in New Mexico, Brittany Sontag, 4-H agent in the Bernalillo County Extension Office, has been working with local schools by introducing students to simple aquaponics systems consisting of goldfish and herbs during the school year. If are in the Albuquerque area, you can visit the Sanctuary at ABQ, a non-profit organization that promotes aquaponics and the incorporation of a STEM-based curriculum into schools (https://sanctuaryatabq.org/-/9OFqz01hVPI80zqhW*Rtz-/page/who-we-are). Additionally, The Santa Fe Community College Controlled Environment Agriculture program (SFCC-CEA) is currently connecting with high schools across the state to let them know about Dual Credit opportunities through online delivery. Teachers interested in learning more about how SFCC instructors can teach college classes to their students online in areas like hydroponics, aquaponics or greenhouse management can reach out to Charlie Shultz, Lead Faculty at richard.shultz@sfcc.edu. Grant opportunities and summer workshops for teachers are also being developed through SFCC-CEA. Contact Charlie Shultz for more information.

References

Aquaponics general overview:

Sallenave, R. 2014. Is Aquaponics Right for you? https://pubs.nmsu.edu/_h/H170.pdf

Sallenave, R. 2016. Important Water Quality Parameters in Aquaponics Systems

https://pubs.nmsu.edu/_circulars/CR680.pdf

Sallenave, R. and R.C. Shultz. 2019. Decoupled Aquaponics: A comparison to single-loop aquaponics

https://pubs.nmsu.edu/_h/H173.pdf

Aquaponics as a teaching tool:

<https://www.aquaponicsusa.com/education/aquaponics-in-the-classroom.html>

<https://www.ecolifeconservation.org/what-we-do/sustainable-agriculture/in-the-classroom/>

<https://www.ffa.org/the-feed/chapter-raises-produce-with-aquaponics/>

https://link.springer.com/chapter/10.1007/978-3-030-15943-6_22

<https://www.aquaponicsusa.com/education/where-to-get-an-aquaponics-grant.html>

<https://www.100gardens.org>

Building aquaponics systems:

<https://www.aces.edu/wp-content/uploads/2021/02/ANR-2711-TabletopAquaponics021821L-A.pdf>

<https://foodchainlex.org/wp-content/uploads/2015/12/Barrel-System-Manual.pdf>

<https://assets-global.website->

files.com/5cfe1ff171000a855754a32f/5d12253d1d7acc44321b02c2_EE_Exp_Aquaponics_LowRes%5B1%5D.pdf

Aquaponics curricula:

https://gofile.me/6cBnf/0ERDbRppr?fbclid=IwAR2FS0JXKTxDy4CeHc6iGNl_Gjv0zrLhWfI3cKjlufabzo48HzFy2Z4MRpE

http://www.tinyhousebiggarden.com/Aquaponics_Lesson_Plans_-_curriculumI.htm

<https://www.theaquaponicsource.com/shop/books-videos-software/books/aquaponics-complete-curriculum-set/>

<https://assets-global.website->

files.com/5cfe1ff171000a855754a32f/5d12253d1d7acc44321b02c2_EE_Exp_Aquaponics_LowRes%5B1%5D.pdf



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