Yabby aquaponics

## Summary

This unit provides students with the opportunity to investigate the importance of aquaculture production to our society. It integrates content from multiple contexts, aquaculture, aquaponics and digital technologies. Successful automation of an aquaponics system using digital technologies will provide students with an understanding of how these technologies can be blended/harnessed for improved aquacultural production.

Students will address the inquiry question “What global challenge could be addressed through the adaptation of these technologies?”. They will consider the technologies used in the Yabbies aquaponics system and identify a global environmental challenge that could be addressed through the adaptation of the technologies and explain the benefits.

## Duration

10 weeks 2.5 hours/week

## Outcomes

* **5.1.1** develops ideas and explores solutions to STEM based problems
* **5.2.2** applies cognitive processes to address real world STEM based problems in a variety of contexts
* **5.3.1** applies knowledge and understanding of STEM principles and processes
* **5.3.2** identifies and uses a range of technologies in the development of solutions to STEM based problems
* **5.4.1** plans and manages projects using an iterative and collaborative design process
* **5.4.2** develops skills in using mathematical, scientific and graphical methods whilst working as a team
* **5.5.1** applies a range of communication techniques in the presentation of research and design solutions
* **5.5.2** critically evaluates innovative, enterprising and creative solutions
* **5.6.1** selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
* **5.6.2** will work individually or in teams to solve problems in STEM contexts
* **5.7.1** demonstrates an appreciation of the value of STEM in the world in which they live
* **5.8.1** understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

[iSTEM School Developed Board Endorsed Course (2016)](https://sispprogram.schools.nsw.gov.au/content/dam/doe/sws/schools/s/sispprogram/stem/iSTEM-Syllabus-V3-7_10_16.pdf) © NSW Department of Education for and on behalf of the Crown in right of the State of New South Wales, 2016.

## Unit overview

Students develop an understanding of yabby production in Australia and different production systems from large scale (ponds) to small scale (tanks and aquaponics). Students research relevant practices and technologies and apply their understandings to arrive at a solution to the inquiry question. Students develop skills in analysing the needs of a system and explore digital technologies to provide a layer of automation to improve the system. Students code, build and test the digital technologies control system and evaluate the design and implementation of automation to increase efficiency and production. Students determine and propose how the combination of technologies could provide a solution to the inquiry question and present their findings.

## Resources

[The Yabby unit](https://www.nswdpi-schools-program.com/yabby-unit) – NSW Department of Primary Industries schools program

* The yabby unit workbook (pdf)
* Folio 1 – design and code an aquaponics system (pdf)
* [The detective work behind the Budj Bim eel traps World Heritage bid](https://theconversation.com/the-detective-work-behind-the-budj-bim-eel-traps-world-heritage-bid-71800)
* Australian Aquatic Biological [Crayfish List – Freshwater Crayfish of Australia (2020)](https://www.aabio.com.au/crayfish-list/)
* Crayfish plaque - [agriculture.gov.au/sites/default/files/documents/infection\_with\_aphanomyces\_astaci.pdf](https://www.agriculture.gov.au/sites/default/files/documents/infection_with_aphanomyces_astaci.pdf)
* White spot - [outbreak.gov.au/current-responses-to-outbreaks/white-spot-disease](https://www.outbreak.gov.au/current-responses-to-outbreaks/white-spot-disease)
* Porcelain disease - [dpi.nsw.gov.au/fishing/aquaculture/publications/species-freshwater/freshwater-yabby](https://www.dpi.nsw.gov.au/fishing/aquaculture/publications/species-freshwater/freshwater-yabby)
* farming and handling of yabbies - [youtube.com/watch?v=mJJHAitV\_gQ](https://www.youtube.com/watch?v=mJJHAitV_gQ)
* Redclaw - [fao.org/fishery/culturedspecies/Cherax\_quadricarinatus/en](http://www.fao.org/fishery/culturedspecies/Cherax_quadricarinatus/en)
* what is Aquaponics? - [aquaponics.com/aquaponics-in-schools/aquaponics-information/](https://aquaponics.com/aquaponics-in-schools/aquaponics-information/)
* living wall and vertical farming systems with aquaponics - [onlinelibrary.wiley.com/doi/full/10.1111/are.13601](https://onlinelibrary.wiley.com/doi/full/10.1111/are.13601)
* Aquaponics Australia and Solar Energy - [youtube.com/watch?v=ih7MsyUaosU](https://www.youtube.com/watch?v=ih7MsyUaosU)
* Aquaponic farming saves water, but can it feed the country? - [youtube.com/watch?v=pqjHT8MFSow](https://www.youtube.com/watch?v=pqjHT8MFSow)
* Australian vegetable farmers speak about Economy of Scale - [youtube.com/watch?v=KkYnqs5hn74](https://www.youtube.com/watch?v=KkYnqs5hn74)
* build a small-scale DIY aquaponics system - [youtube.com/watch?v=VaY5hMxTExQ](https://www.youtube.com/watch?v=VaY5hMxTExQ)
* Raspberry Pi Controlled IBC Aquaponics - [youtube.com/watch?v=n0BeTrUN03g](https://www.youtube.com/watch?v=n0BeTrUN03g)
* Internet of food: Arduino-based, urban aquaponics in Oakland - [youtube.com/watch?v=3IryIOyPfTE](https://www.youtube.com/watch?v=3IryIOyPfTE)
* Internet of farming: Arduino based, backyard aquaponics - [youtube.com/watch?v=X2wWTadsBDA](https://www.youtube.com/watch?v=X2wWTadsBDA)
* Developing an Aquaponics System to learn sustainability and Social Compromise Skills - [researchgate.net/publication/289367876\_Developing\_an\_Aquaponics\_System\_to\_Learn\_sustainability\_and\_Social\_Compromise\_Skills](https://www.researchgate.net/publication/289367876_Developing_an_Aquaponics_System_to_Learn_sustainability_and_Social_Compromise_Skills)
* Arduino controlled aquaponics garden: student project - [programmingelectronics.com/arduino-controlled-aquaponics-garden-student-project/](https://programmingelectronics.com/arduino-controlled-aquaponics-garden-student-project/)
* Build an aquaponics garden with Arduino - [makezine.com/projects/aquaponic-garden/](https://makezine.com/projects/aquaponic-garden/)

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| Content | iSTEM outcome | Teaching and Learning | Evidence of Learning | Adjustments and registration |
| applies a range of communication techniques in the presentation of research and design solutions  demonstrates an appreciation of the value of STEM in the world in which they live | 5.5.2  5.7.1 | **Inquiry question:** What global challenge could be addressed through the adaptation of these technologies?  **Teacher**  Identifies at which point of the unit that the inquiry question task is introduced. This may be at commencement with work samples or towards the end when students have developed a deeper understanding of concepts.  Presents examples of current and upcoming environmental challenges, such as growing populations and food security.  Guide students to the [United Nations Sustainable Development Goals](https://www.un.org/sustainabledevelopment/sustainable-development-goals/) as a starting point for investigation  Identifies the intended audience for the inquiry task presentation, for example a science fair for primary aged students.  **Students**  Use the Internet and other sources to identify and describe an environmental challenge.  Using the researched information, students prepare a presentation explaining how the Yabby aquaponics technologies could be adapted in a mode suitable for the intended audience. | Students present a student directed inquiry task, identifying and describing the global challenge and explaining how the Yabby aquaponics technologies could be adapted to meet the challenge and the benefits.  Students can make connections between how technologies can be applied to solve environmental challenges. |  |

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| Content | iSTEM outcome | Teaching and learning | Evidence of learning | Adjustments and registration |
|  |  | **Teacher**  Selects and/or modifies the inquiry question and chooses when to introduce it into the project sequence.  Explains the reasons for using yabbies as opposed to fish or aquatic |  |  |
| Explains the interactions between the agricultural sector and Australia’s economy.  Explore the impact of historical Aboriginal aquaculture and make links to sustainable agricultural practices. | 5.3.1  5.7.1 | **Teacher**  Define aquaculture and compare to traditional terrestrial farming enterprises.  Identify a range of commercial aquaculture enterprises both nationally and for the local region.  Describe Aboriginal aquaculture enterprises using Budj Bim as a case study and link the practices that were used when this system was fully operational to current commercial ventures to draw similarities and differences.  **Students**  Examine the glossary (page 5) to discover words that may be used throughout the unit.  Explore the history of aquaculture in Australia.  Read [The detective work behind the Budj Bim eel traps World Heritage bid](https://theconversation.com/the-detective-work-behind-the-budj-bim-eel-traps-world-heritage-bid-71800)  The associated questions throughout the [student workbook](https://www.nswdpi-schools-program.com/yabby-unit) and [design production folio](https://www.nswdpi-schools-program.com/yabby-unit) may guide student research throughout the project. | Students use correct terminology when describing aquaculture as a managed practice or enterprise.  Students participate in classroom discussions to demonstrate understanding of Aboriginal aquaculture enterprises, including Budj Bim. |  |
| Explains the interactions between the agricultural sector and Australia’s economy. | 5.3.1  5.7.1 | **Teacher and students**  Discuss the importance of aquaculture to the NSW economy.  Compare aquaculture value at a state level to other major commodities.  **Students**  Research the economic value of yabbies. | Students accurately describe a range of commercial aquaculture enterprises in NSW.  Students use tables to display information about the economic value of aquaculture in NSW.  Students make an assessment of how yabbies might form part of a sustainable food solution. |  |
| Explains why Australian crayfish have been used in agricultural enterprises and have been developed to benefit Australia’s economy. | 5.3.1 | **Students**  Investigate a range of native freshwater crayfish species in Australia. Identify which species are commercially grown in aquaculture production.  For one commercially grown freshwater crayfish create an information based report as directed in the student workbook (page 14).  For one non-commercially grown freshwater crayfish species, investigate its native habitat and identify threats to the species (page 14) | Students’ research demonstrates correct terminology and shows understanding of key facts. |  |
| Research and observation | 5.3.1 | **Practical – parts of a freshwater crayfish**  **Teacher**  Demonstrate and lead a safe dissection of a yabby highlighting key parts of yabby anatomy.  Modifications to this activity could include using food grade prawns as an alternative or using the internet to find [images of yabbies](https://www.aabio.com.au/crayfish-list/) to carry out the activity.  Australian Aquatic Biological has published [Crayfish List – Freshwater Crayfish of Australia (2020)](https://www.aabio.com.au/crayfish-list/) listing a large range of various crayfish.  **Students**  Follow the sequence of steps in the student workbook (pages 18-19) and label the parts of the crayfish on page 20.  Alternatively, identify and label yabby anatomy from sourced images and practise using correct terminology. | Students can identify the basic anatomy of a yabby which may include labelling diagrams.  Students can use the correct terminology in written and verbal responses. |  |
| Investigate and apply understanding of yabby biology and behaviours – diet, reproduction and growth | 5.3.1 | **Students**  Investigate the diet, reproductive cycle, growth and management of commercially grown yabbies.  Develop a calendar of operations for yabby management. | Students can identify dietary requirements and other conditions for yabby growth.  Students can identify optimum conditions, such as water temperature, for yabby reproduction.  Students apply their understanding to construct a basic calendar of operations for yabby management. |  |
| Aquaculture production of yabbies- regulations and biosecurity | 5.3.1 | **Students**  Investigate biosecurity issues and regulations relevant to yabby production, including the following diseases:   * [Crayfish plague](https://www.agriculture.gov.au/sites/default/files/documents/infection_with_aphanomyces_astaci.pdf) * [White spot](https://www.outbreak.gov.au/current-responses-to-outbreaks/white-spot-disease) * [Porcelain Disease](https://www.dpi.nsw.gov.au/fishing/aquaculture/publications/species-freshwater/freshwater-yabby) | Students can relate the importance of biosecurity and regulations to aquaculture production in NSW.  Students can describe some important Yabby diseases. |  |
| Investigates and implements responsible production systems for animal enterprises | 5.3.1 | **Teachers**  Distinguish between the four most common commercial species of crayfish.   * Yabby (Cherax destructor) grown in NSW * Redclaw (Cherax quadricantus) * Hairy Marron (Cherax tenuimanus) * Smooth Marron (Cherax cainii)   **Students**  Using a range of sources students investigate aspects of crayfish management including:   * pond design * supplementary feeding * harvesting.   [Farming and handling of yabbies](https://www.youtube.com/watch?v=mJJHAitV_gQ)  Crayfish pond set ups and harvesting methods on the Fisheries and Aquaculture Department page - [Redclaw](http://www.fao.org/fishery/culturedspecies/Cherax_quadricarinatus/en) (Cherax quadricantus) | Students can explain a range of essential management features:   * pond design/layout * supplementary feeding * harvesting methods   Students participate in classroom discussions. |  |
| Recognises and contrasts intensive plant and animal production systems | 5.3.1 | **Teacher**  Investigate the basic concept of aquaponics and compare to the aquaculture systems and designs studied in previous sections. Outline the similarities and differences of the two systems. Resources may include:   * [What is Aquaponics?](https://aquaponics.com/aquaponics-in-schools/aquaponics-information/) (discusses aquaculture, hydroponics and aquaponics) * [The potential for combining living wall and vertical farming systems with aquaponics](https://onlinelibrary.wiley.com/doi/full/10.1111/are.13601) * [Aquaponics Australia and Solar Energy](https://www.youtube.com/watch?v=ih7MsyUaosU) * [Aquaponic farming saves water, but can it feed the country?](https://www.youtube.com/watch?v=pqjHT8MFSow) * [Australian vegetable farmers speak about Economy of Scale](https://www.youtube.com/watch?v=KkYnqs5hn74)   **Student**  Compare and contrast aquaculture, hydroponics and aquaponics. | Students can recognise that aquaponics is the combination of aquacultural production with hydroponics and describe the differences between each. |  |
| 9.1 processes of design   * identifying problems | 5.1.1  5.5.2  5.6.1 | **Teachers**  **Note:** page numbers now refer to the ‘**design and code an aquaponics system**' document.  Outline the ‘iSTEM engineering design process’  Establish requirements of digitally controlled aquaponics project, including:   * defining the brief * constraints * final product specifications * documentation.   **Students**  Investigate the basic concept of aquaponics and consider elements to automate using digital technologies.  Examine ‘the design and production process’ (page 9) and compare with the iSTEM engineering design process.  Complete learning activities (pages 10-11) as either a guided practice or as a template for resolving design issues. | Students can describe the concept of aquaponics and identify elements which could be automated.  Students recognise different design models and make any necessary adjustments. These decisions will be evident in the reflection and evaluation sections of their engineering journal.  Students clearly identify criteria which can be used to evaluate success of project at completion. |  |
| 9.2 presentation and communication technologies | 5.4.2 | Record progress throughout the project development phases in an engineering journal. | Engineering journal will reflect the design thinking, including some justification of decision choices and ongoing evaluation, as well as overall progress of the project. |  |
| 9.1 processes of design   * identifying problems * generating ideas   9.2 presentation and communication technologies | 5.1.1  5.5.2  5.6.1 | **Students**  Research and review existing ideas and solutions which may include the following:   * [Raspberry Pi Controlled IBC Aquaponics](https://www.youtube.com/watch?v=n0BeTrUN03g) control system ideas * [Internet of food: Arduino-based, urban aquaponics in Oakland](https://www.youtube.com/watch?v=3IryIOyPfTE) * [Internet of farming: Arduino based, backyard aquaponics](https://www.youtube.com/watch?v=X2wWTadsBDA) * [Developing an Aquaponics System to learn sustainability and Social Compromise Skills](https://www.researchgate.net/publication/289367876_Developing_an_Aquaponics_System_to_Learn_sustainability_and_Social_Compromise_Skills) * [Arduino controlled aquaponics garden: student project](https://programmingelectronics.com/arduino-controlled-aquaponics-garden-student-project/) * [Build an aquaponics garden with Arduino](https://makezine.com/projects/aquaponic-garden/)   Analyse these and/or other examples of existing aquaponics systems and identify the key components.  Relate these components and their functions to the identified needs or purpose of the design.  Use design thinking and formulate key ideas around automation, construction methods and constraints. |  |  |
|  |  | **Students**  Record evidence of any research in design journal and adhere to accepted standards for referencing. | Any list of research performed should display sufficient breadth to enable a range of suitable options to be considered and show some form of annotation to demonstrate reasoning and effective search strategies. |  |
|  | 5.6.1  5.8.1 | **Teachers and Students**  Identify related WH&S risks associated with project, for example:   * plan * design * materials * tools * and production processes.   Use activities on page 14 to further evaluate suitability of design solution. | Relevant considerations are documented within the student engineering journal. |  |
| 9.1 processes of design  project management | 5.4.1  5.5.1  5.6.2 | **Students**  Plan and manage projects individually and/or collaboratively.  Complete a detailed action plan for developing the aquaponics control system, either using the template (page 13) or another time management tool. | Students document action plan within engineering journal. Action plan exhibits a logical sequence of activities to be completed with appropriate timelines indicated. |  |
| 9.1 processes of design   * generating ideas | 5.1.1  5.2.2  5.3.1  5.5.1 | **Students**  Analyse the example of an aquaponics system represented on page 15 of the design production folio document and examine the generic electrical components used and their functions.  Use the example system to collate basic functions and commands for a typical aquaponics system.  Relate these functions to the use of specific digital control technologies.  Use the pseudocode and IPO chart templates on pages 16-18 to model the functions and processes. Repeat for any extra functions identified. |  |  |
| 9.2 presentation and communication technologies | 5.4.2 | Record progress throughout the project development phases in an engineering journal. | Engineering journal will reflect the design thinking stages, including some justification of decision choices and ongoing evaluation, as well as overall progress of the project. |  |
| 9.1 processes of design   * generating ideas | 5.1.1  5.2.2  5.3.2  5.5.1 | **Students**  Brainstorm and develop possible design solutions. |  |  |
| 9.3 realisation, evaluation, research methods and experimentation   * test possible solutions to problems | 5.1.1  5.2.2  5.3.1  5.5.1  5.5.2  5.6.1 | **Students**  Critically evaluate current designs and research feasibility of the designs in reference to the design brief and project constraints.  Use activities on pages 23–24 to guide evaluation. | A variety of evaluation thinking tools could be used showing evidence of student’s critical thinking, for example:   * SWOT analysis |  |
| 9.2 presentation and communication technologies | 5.4.2 | Record progress throughout the project development phases in an engineering journal. | Engineering journal will reflect the design thinking stages, including some justification of decision choices and ongoing evaluation, as well as overall progress of the project. |  |
| 9.3 realisation, evaluation, research methods and experimentation   * test possible solutions to problems | 5.2.2  5.3.2  5.5.1 | **Students**  Develop code for digital control technologies to automate operation of aquaponics systems.  Test that the code will work with individual components or sections of the system prior to building.  Test for syntax and logical errors.  Debug and modify as necessary.  Record steps undertaken in developing the final version of code in engineering journal. | Students have annotated their code using various methods, for example:   * internal or inline comments * describing small extracts * using highlighting and/or callouts on screenshots   Students can verbally describe the function of any part of their code.  Students demonstrate skills in using an integrated development environment (IDE) and in troubleshooting and debugging code. |  |
| 9.3 realisation, evaluation, research methods and experimentation   * test possible solutions to problems * use tools, materials and processes to produce a solution to an identified problem * conduct continual evaluations throughout the design and production of the minor project   9.4 mechanical knowledge  9.5 creative and innovative approaches to solve problems | 5.1.1  5.2.2  5.3.2  5.5.2 | **Students**  Build the digital control technologies component of the aquaponics system.  Upload code to microcontroller and test operation against design scenario.  Debug and modify as necessary.  Document changes and record final code in engineering journal. Document with images and/or photos.  Review code and system operation and propose/initiate improvements or optimisations.  Continue to record progress throughout the project build and development. |  |  |
| 9.2 presentation and communication technologies  9.3 realisation, evaluation, research methods and experimentation   * evaluate the project in terms of the identified criteria for success. | 5.1.2  5.2.2  5.3.1  5.5.1  5.7.1  5.8.1 | **Students**  Carry out reflection and evaluation of their final product and project work.  Use the questions on pages 28-29 to guide evaluation. | Engineering journal will reflect some justification of decision choices and ongoing evaluation. |  |

## Evaluation

Evaluation of learning activities should be an ongoing process that happens throughout the delivery of this unit. Teachers should document their evaluation of learning activities throughout the program. The space provided below is to evaluate the overall unit of work.

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