YEAR 6
STEM Project 1

Science Technology Engineering and Mathematics (STEM) Project – Teacher's Guide

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

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EARTH SCIENCE WESTERN AUSTRALIA

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How To Use This Resource

The PALMS STEM projects are designed to be used either to supplement normal science lessons in the Earth and Space Science area or to be used as stand-alone projects with science classes, STEM clubs or extension classes.
They are organised using the following sequence:

1. The Challenge
2. Find Out More and Get Thinking
3. Ways To Meet The Challenge
4. Could It Be Better?
5. Report Back To Base

The projects are designed to be completed independently by students although teacher supervision, especially when using equipment such as 3D printers, is strongly recommended.
To clarify with students what skills they need to be using when working on STEM projects, an accompanying PowerPoint presentation titled 'What do STEM Skills look like?' has been prepared. This should be discussed with the students before starting the main project. It should be reinforced with the students that we are not asking them to think of ways to address the scenarios presented in this resource, but to identify the skills they would use. The STEM skills discussed here align with the WA Department of Education definitions found here:
https://www.education.wa.edu.au/what-is-stem-
Students will be asked at the end of the project to identify which STEM skills they have used, to increase their overall understanding of the importance of these skills.

A series of project maps for the STEM project have also been created to allow teachers and students to clearly see some of the many aspects that

could be investigated as part of the project. These are included as Appendix 1. There is a full STEM project map which may be too overwhelming for some students at first so there are also a series of more focused maps (numbered 1-5) included.

This project map could be used in several ways:

- For students to choose one specific aspect of the larger project to work on
- For teachers to choose one branch for the class to work on, as a theme for the whole class
- As a thinking prompt for any other aspects of the larger project that could be investigated – the project map is definitely not exhaustive!

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International Space Farm

The Challenge

One of many global issues that the planet is facing is food security. For a person to be considered food secure, there must be food available to them, it must be affordable and the food must be good enough to provide them the nutrition needed to be healthy.

There are many complex reasons for food insecurity including; poverty, trade, environmental issues (water, loss of biodiversity), and urbanisation of productive land. The Global Education website has some good background information on this that teachers may find useful (https://globaleducation.edu.au/global-issues/gi-food-security.html).

This STEM Project will focus on the difficulties faced when growing food crops.

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Growing crops for food on planet Earth is becoming increasingly difficult due to issues such as:

- an increasing population,
- natural disasters destroying food crops and land areas used for farming,
- climate change,
- pests and diseases affecting crops and livestock, and
- the lack of available land suitable for farming.

One possible solution to solve some of these issues is to consider developing an International Space Farm (ISF). The idea of a farm that is not based on Earth is a great way to pique students' interest in the project. This could be a farm based on a station orbiting the Earth or a farm on another planet, even a moon! There are many aspects to be considered in designing and operating an International Space Farm.

This project has been broken into four main areas:

- Design and build the farm
- What crops will you grow?
- What do you need to grow the crops?
- How will you harvest, store and distribute the crop yield?

These areas are then further broken down into smaller areas which are outlined in the STEM project maps 1-5 (Appendix 1).

A list of keywords for this project is also provided (Appendix 2).

Links to the Australian Curriculum are outlined in Appendix 3, Due to the nature of this project, not all curriculum points will be covered by all students.

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Find Out More and Get Thinking

Students will need to know a bit more about what food security is and how it affects us in Australia (as well as people across the world). Listed below are some stimulus questions and links to articles and videos that will help get students thinking about the problem. You could either ask students to research one or more of these questions themselves or prepare some material yourself to present to the class.

*Does **food security** affect people in WA?*

- An article on food security in WA – contains statistics https://www.abc.net.au/news/2017-10-16/foodbank-wa-hunger-report-demand-increasing/9052956

*Are there better places we could be **growing food** in **Australia**?*

- A Behind The News segment about an election promise of a food bowl in Australia's north – a little out of date regarding the politicians mentioned but other facts are still relevant - http://www.abc.net.au/btn/classroom/northern-food-bowl/10529926
- A Behind the News segment about changing conditions and how Tasmania could be the next food bowl (and teacher resource) - http://www.abc.net.au/btn/classroom/food-bowl/10537258 http://www.abc.net.au/btn/resources/teacher/episode/20100223-foodbowl.pdf

*What **effect** does a **growing population** have on **where** our **food** comes from?*

- An article on how urban sprawl is reducing the size of Melbourne's food bowl - https://www.abc.net.au/news/rural/2019-03-27/melbournes-food-bowl-at-risk-to-urban-sprawl/10943564

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*Why do **droughts, floods, cyclones** and other weather events **impact food supply** so much?*

- An article about the reduction of available fresh food due to conditions in the eastern states - https://www.abc.net.au/news/rural/2019-03-14/expensive-veggies-and-small-fruit-result-from-drought/10895426
- An article about food shortage fears after a major cyclone in Vanuatu - https://www.abc.net.au/news/2015-03-18/cyclone-pam-fears-of-food-shortages-vanuatu-huge-damage-revealed/6327658
- An article about the impacts of Cyclone Olwyn on Carnarvon, WA - https://www.abc.net.au/news/rural/rural-news/2015-08-26/gascoyne-growers-cyclone-olwyn-snapshot/6721352
- An article about predicted price rises for fruit and vegetables due to pressures, including weather extremes (also looks at the rising energy prices and labour costs) - https://www.abc.net.au/news/rural/2019-04-08/food-price-crunch-warning/10980234

*Why do places in Australia get cut off and **run out of supplies**, particularly fresh food, during cyclones and floods?*

- An article about Broome's isolation following a record wet season and Cyclone Kelvin - https://www.abc.net.au/news/2018-02-20/broome-smashes-annual-rainfall-record-after-less-than-two-months/9462962

*How can **pests** (e.g. locusts or mice) **affect crops**?*

- A Behind the News segment on locusts And their impact on farms - http://www.abc.net.au/btn/classroom/locust-plague/10535740

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*Does **food security** affect **people** around the **world** in **different** ways? For example, how do people in South Sudan cope with a lack of food compared to people in Australia? Who do they go to for help?*

- Video on what food security is and what it means for less developed countries - https://www.worldvision.com.au/get-involved/school-resources/detail/get-connected-food-security
- Behind the News segment on being a starving kid in Yemen - http://www.abc.net.au/btn/classroom/yemen-famine/10611588
- Behind the News segment on famine in South Sudan - http://www.abc.net.au/btn/classroom/south-sudan-famine/10523354

*Is it possible to grow **food** in **space**? What **challenges** might we face?*

- An overview of space farming - https://science.howstuffworks.com/space-farming.htm
- An outline of the challenges and experiments that have been conducted - https://en.wikipedia.org/wiki/Space_farming
- An overview of Astrobotany - https://en.wikipedia.org/wiki/Astrobotany

*What **research** is currently being conducted on **growing food** in **space**?*

- A DNews story from 2015 'How astronauts grow plants in space', outlining how lettuce was grown on the ISS using the VEGGIE system - https://youtu.be/bIc51VuEPng
- A NASA article, 'Why study plants in space' – some history of what has been done so far. - https://www.nasa.gov/mission_pages/station/research/news/plants_in_space.html
- A description of the experiment conducted around growing food in space (by NASA) - https://www.nasa.gov/mission_pages/station/research/experiments/

explorer/Investigation.html?#id=1159

- High school citizen science project looking at plant choice for the ISS in collaboration with NASA. It provides information on the set up and what they've found so far. - https://sites.google.com/site/growingbeyondearth/products-services

*What **problems** could we encounter **growing plants** on **other planets** like Mars?*

- Overview video from 2014 'Can we grow plants on Mars?'. Talks about Curiosity rover soil sampling and experiments replicating this soil on Earth. Also mentions problems like light, temp and gravity - https://youtu.be/Lav4ydRaN7k
- Article about space farming - https://www.space.com/9597-space-farmers-grow-crops-planets.html

*How are scientists currently growing plants on the **International Space Station** (ISS)?*

- A description of the VEGGIE vegetable production system on the ISS - https://www.nasa.gov/mission_pages/station/research/experiments/explorer/Facility.html?#id=374
- A video explainer of the plants grown in space - https://youtu.be/SgpU08WJm0c

A further search on the NASA website https://www.nasa.gov/ using keywords such as space farming, growing food, space crops and ISS food will find a lot of articles on the work NASA is currently doing, mainly on the International Space Station (ISS)

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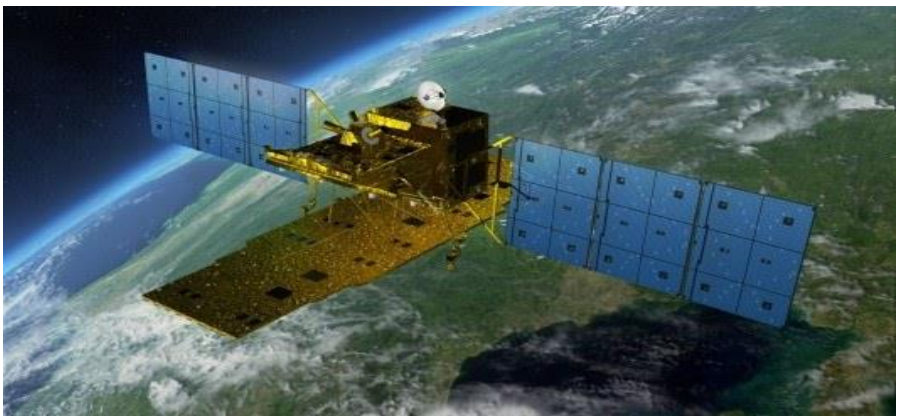
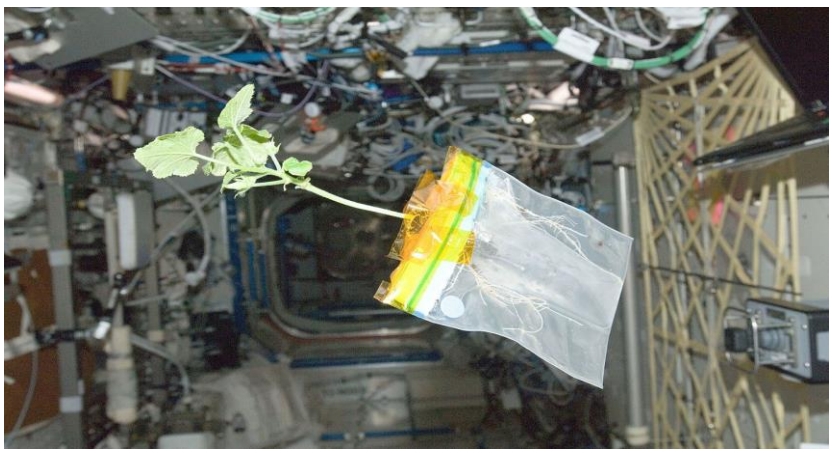
A STEM project research worksheet has been provided in the student booklet. This gives students the opportunity to consider and research the broader issues. If you have chosen a particular section of the broader STEM project map this should be the focus of their research.





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Ways to Meet the Challenge

Before starting to work on meeting the challenge, it is important that students are very clear on what specific problem they are going to be solving. So they can limit the scope of their project and make it achievable. As previously mentioned, this project has been broken into four main areas:

- Design and build the farm
- What crops will you grow?
- What do you need to grow the crops?
- How will you harvest, store and distribute the crop yield?

You may like to ask students to choose one of these areas (or assign them one) or perhaps tell the class that they will all be working on one of these four areas and assign each group a more specific point to work on, collaborating with other groups to solve the main problem as a class.
At this stage, students should spend **at least one lesson** brainstorming and refining their ideas. If possible, it would be good to spend another lesson on this step before allowing the students to move on. It should be stressed that thinking through and refining their ideas is a really important step that should be given enough time as they will be very keen to jump in and start building things or doing experiments. Thinking more about the way they can solve a problem will help them to understand the problem more fully, which will ultimately lead to a better solution, and it is a more efficient use of resources.
Once they have thought more about their specific problem they may identify that they need more information. In this case they could be given another copy of the STEM project research worksheet to guide to assist.
Once they have thoroughly thought through a possible solution to their problem (and conducted any further research they need to), they may then move on to building prototypes, designing experiments, testing and reviewing. This process is likely to take several lessons, but it is also important to give students clear deadlines they must meet to enhance their chances of finishing the project.

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Remind students that prototypes do not need to be perfect and are a representation of what a final product may look like. For some sections listed, the students may not be able to make a working prototype but may produce a detailed diagram or map to illustrate their solution. Some students may need to carry out some trials or experiments growing plants to test their ideas on aspects, such as water requirements and growing mediums. This will obviously take a longer period of time so it may not be possible to work on the project continuously.

Below we have listed some prompts for a couple of the areas listed in the STEM Project Map for the International Space Farm to give you an idea of how projects may be structured. As mentioned previously, students may come up with other areas they would like to investigate. Not all areas have been expanded like this, to allow teachers some freedom in tailoring the project to their students.

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1. Design and build the farm

Space station or on another planet (or moon)?

- Investigate the conditions on the International Space Station (ISS) - gas levels, gravity, access to water, power sources, size of space station required
- Investigate the conditions on other planets or moons - gas levels
- Decide which option would be best and justify why you made this choice.
- Draw a design for your International Space Farm then build it!

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Materials to make farm

What materials should the International Space Farm be built from?

Consider the conditions it may have to withstand - temperature extremes, radiation (from Sun), gravity, meteor impacts, weather conditions (on a planet)

Consider how easy it would be to transport the materials into space and build it

Design and conduct an experiment to test some different building materials e.g. for strength, heat resistance etc

Other areas within this topic to consider:

- Power & water supply/generation
- Size/capacity of farm
- Layout of farm

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2. What crops will you grow?

Nutrient content of plants

- Investigate how much energy, vitamins and other nutrients people need from their food to be healthy?
- Investigate what nutrients are provided to humans by different crops? (e.g. vitamins, minerals, carbohydrates, sugars etc.)
- How much of each crop would people need to eat to get as much of their required nutrients as possible?
- Design and conduct an experiment to test some different crops for their starch content

Useful resource: https://www.eatforhealth.gov.au/node/add/calculator-energy

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Water requirement of plants

- Investigate how much water different types of crops require
- Consider how water could be delivered to the plants - sprays, drip feed, hydroponic systems?
- Would the water requirements of the crops be the same throughout their growing cycle? (e.g. do they need more water when seeds first germinate?)
- Design and conduct a series of experiments to test some different crops and their water requirements

Other areas within this topic to consider:

- Effect of gravity/lack of gravity
- Do the crops need to be pollinated? How?
- Which crops will produce the most food?

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3. What do you need to grow crops?

Fertiliser -

type, how much, when?

- Investigate what nutrients plants require to be strong and healthy. What kind of fertiliser can supply these?
- Investigate when the best time to add fertiliser is for maximum crop yield?
- What is the ideal amount of fertiliser to add? Consider the balance of costs and crop yield
- Design and conduct a series of experiments to test which fertiliser is best, how much you should use and when it should be applied.

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Growing medium

(soil, water, something else)

Investigate what mediums it is possible to grow crops in. Remember you may be using these in micro-gravity.

Investigate what special equipment you may need to grow crops in different mediums.

Consider the space requirements of different growing mediums and if you need to add nutrients for the plants to the medium.

Design and conduct a series of experiments to test which growing medium gives the best crop yield.

Useful resource: https://blogs.nasa.gov/kennedy/2019/03/12/plant-experiment-veg-03-h-initiated-on-space-station/

Other areas within this topic to consider:

- Water – how much, quality, ways to distribute?
- Sunlight – how long, intensity?
- Pollination – by birds, bees, insects or artificial?

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4. How will you harvest, store and distribute the crop?

Transport to and from Earth

Investigate what type of transport could be used to move the harvested crop to Earth from the ISF. Does it have to be a rocket-type vehicle?

Investigate the cost of launching vehicles into space currently. Also consider how easy or difficult it is for that vehicle to return to Earth.

Consider if a vehicle needs to be powered or if the graviational pull of the Earth could be used to transport the harvest back to the surface.

Design, build and test a transport vehicle to move the harvest from the ISF to Earth.

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Manned or unmanned farm?

- Investigate the jobs that people currently do to harvest crops on Earth.
- Investigate how robots, artificial intelligence or other forms of technology are being used to harvest and transport crops.
- Consider what would be different in the design of the ISF if there were no people there.
- Program a robot to harvest and transport a crop.

Useful resources: https://www.spacex.com/news/2013/03/31/reusability-key-making-human-life-multi-planetary
SpaceX making and testing re-usable rockets

https://www.abc.net.au/news/2019-04-03/robotic-apple-harvest/10965238
Robot that picks apples in NZ

Other areas within this topic to consider:

- Quarantine/food safety requirements
- Storage of harvest – on Earth or on ISF?
- Fair distribution of harvest

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Could It Be Better?

Once students have fully examined the challenge and come up with their solutions, they should then spend some time reviewing their solution to come up with ways it may be improved. There are always restrictions on what students can achieve in a classroom setting due to time, space, budget and equipment availability, so ask the students to think about their solution, if they were to be given unlimited resources. The obvious limitations in this particular project are the ability to explore their solution in a space environment – being able to test the effects of differing gravity, atmosphere and solar radiation.

Aspects for the students to consider to try and put their solution in a real world context:

- Availability of resources – do you have access to enough of the materials? Is there enough of it available in Australia? On Earth?
- Will current technology be useful, or do you need something more?
- Estimate how much it would cost to put your plan in place.
- Estimate how long it would take to put your plan in place.
- Can you do all of this yourself or do you need to bring in some experts? Who might these experts be?
- Did your experiments or tests give you enough information to start an International Space Farm tomorrow? What further experiments or tests might you need to do?

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Report Back To Base

To finish up the International Space Farm STEM Project, students should present their findings back to the class or perhaps even to the school or a wider audience! There are many ways this can be done such as written reports, posters, a STEM Fair, oral presentations, at a parent evening or as a short film. The mode the students use to communicate their findings may also fit into another curriculum area such as English or Digital Technologies.

It is also worth considering if the student's projects would be eligible for entry in one of the many Science and STEM competitions available. Check with your local science teachers' association or community group about competitions or consider national programs such as the CREST (Creativity in Research, Engineering, Science and Technology) Awards run by CSIRO.

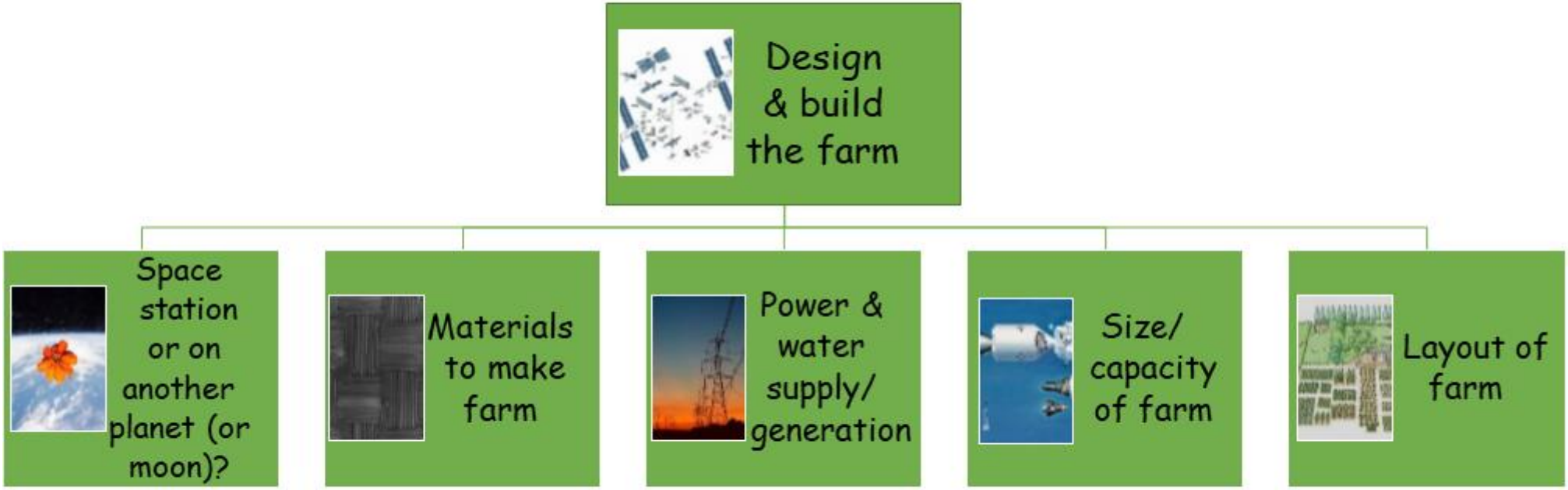
Students should cover the following points in presenting their findings:

- What have we found out or discovered that we didn't know before?
- What did we design, build, program, test etc.?
- What STEM skills have we used? (problem solving, creativity, critical analysis, teamwork, independent thinking, communication, digital literacy)
- What data did we generate in our investigation and what does this show? (this may be in the form of tables or graphs and may not be relevant to every section of the project)
- How could we better investigate the challenge if we had no limit on resources or time?
- What was the most challenging aspect of the project?

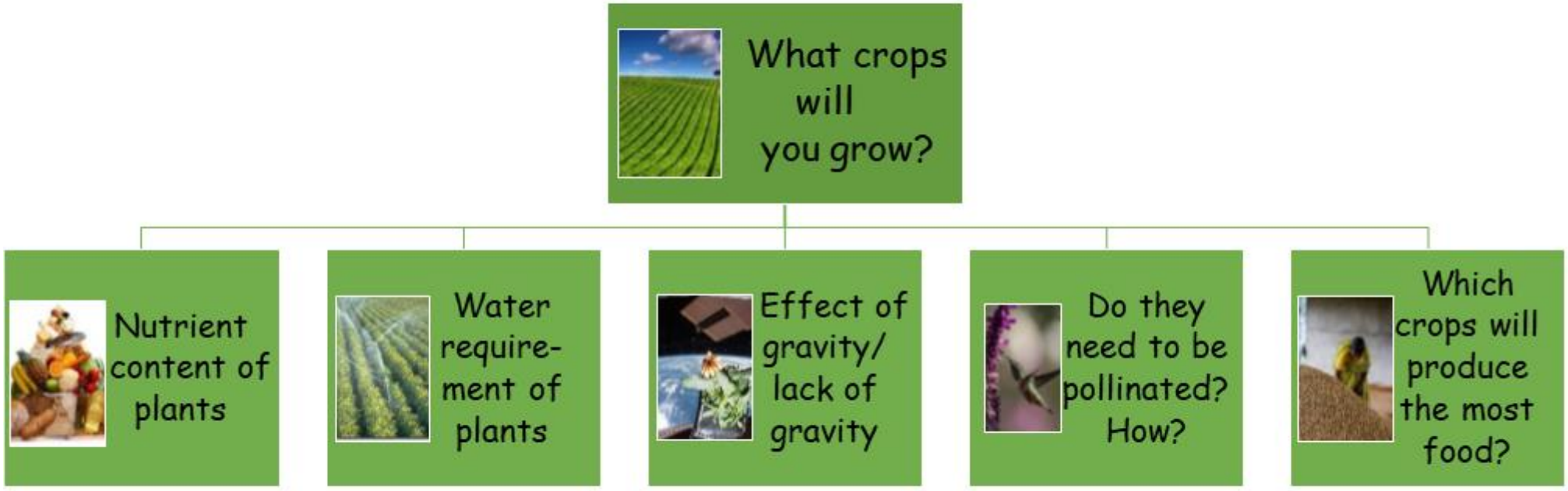
Appendix 1: Full Project Map

Project Map 1

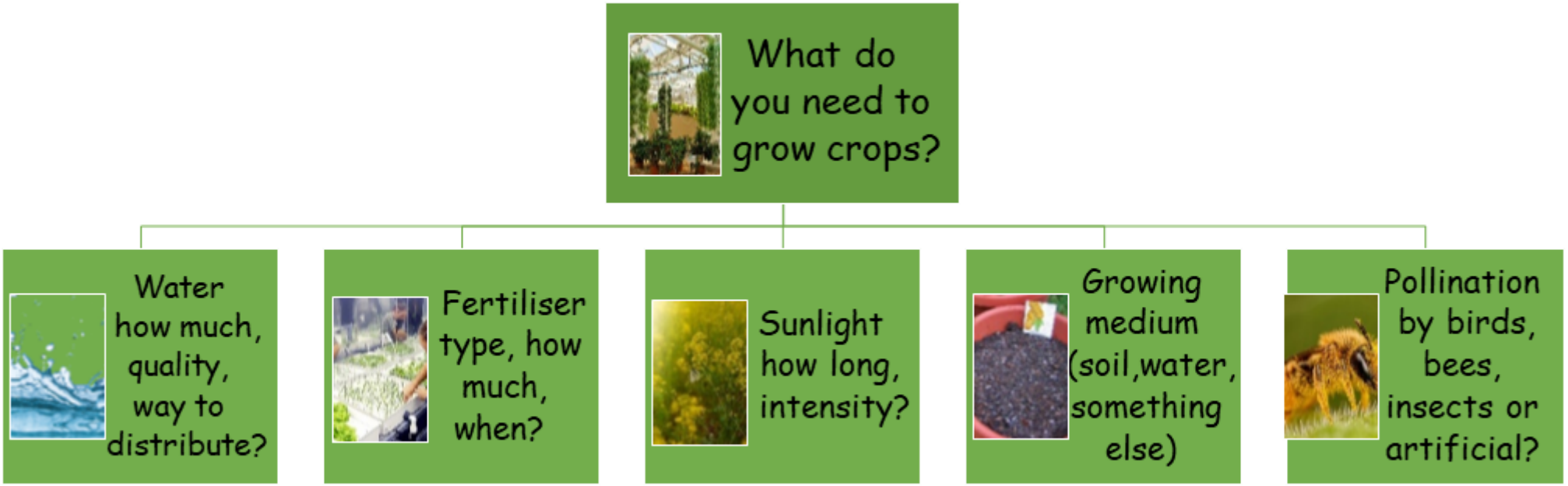
STEM Project Map 2



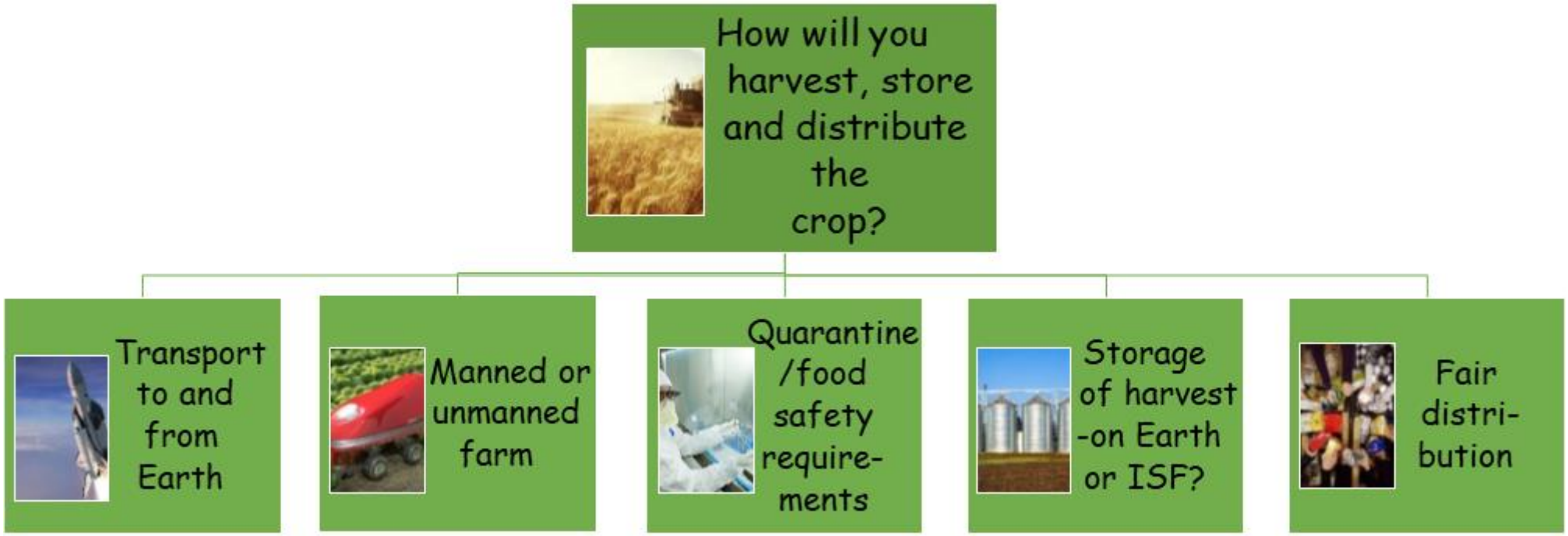
STEM Project Map 3



STEM Project Map 4



STEM Project Map 5



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Appendix 2

International Space Farm Project Keywords

Food security
Sustainability
Food bowl
Transformation
Transfer
Generation
System
Measure
Nutrient
Crop
Yield
Pollination
Pollinator

(Growing) medium
Harvest
Gravity
Microgravity
Orbit
Manned/unmanned
Hydroponic
Distribution
Intensity
Radiation
Atmosphere
Quarantine
Capacity

Urbanisation
Poverty
Overpopulation
Biodiversity
Climate change
Natural disaster
Pest
Disease
Cyclone
Drought

Appendix 3

Year 6 Australian Curriculum links

Note: All curriculum areas may not be covered by each student depending on how the project is organised and assigned.

Science	Technology*	Engineering*	Mathematics
Science Understanding Biological Sciences The growth and survival of living things are affected by physical conditions of their environment (ACSSU094) Earth and Space Sciences Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096) Physical Sciences Electrical energy can be transferred and	**Technologies and Society** How people address competing considerations, including sustainability when designing products, services and environments for current and future use (ACTDEK019) **Food and fibre production** Past performance, and current and future needs are	**Engineering principles and systems** Electrical energy and forces can control movement, sound or light in a product or system (ACTDEK020) **Materials and technologies specialisations** Characteristics, properties and safe practice of a range of materials, systems, tools and	**Number and Algebra** Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers (ACMNA123) Add and subtract decimals, with and without digital technologies, and

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transformed in electrical circuits and can be generated from a range of sources (ACSSU097) **Science as a Human Endeavour** Nature and development of science Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098) Use and influence of science Scientific knowledge is used to solve problems and inform personal	considered when designing sustainable food and fibre systems for products (ACTDEK021) **Food specialisations** Principles of food preparation for healthy eating (ACTDEK022) **Digital systems** Digital systems have components with basic functions and interactions that may be connected together to form networks which transmit different types of data (ACTDIK014)	equipment; and evaluate the suitability of their use (ACTDEK023) **Investigating and defining** Define a problem, and a set of sequenced steps, with users making decisions to create a solution for a given task (WATPPS33) **Designing** Design, modify, follow and represent both diagrammatically, and in written text, alternative solutions using a range of techniques,	use estimation and rounding to check the reasonableness of answers (ACMNA128) **Measurement and Geometry** Connect decimal representations to the metric system (ACMMG135) Solve problems involving the comparison of lengths and areas using appropriate units (ACMMG137) Connect volume and capacity and their units of

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and community decisions (ACSHE100) **Science Enquiry Skills** Questioning and predicting With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232) Planning and conducting Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103) Decide variables to be changed and measured	**Producing and implementing** Select, and apply, safe procedures when using a variety of components and equipment to make solutions (WATPPS36) **Digital implementation** Design, modify, follow and represent both diagrammatically, and in written text, simple algorithms (sequence of steps) involving branching (decisions) and iteration (repetition) (ACTDIP019)	appropriate technical terms and technology (WATPPS35) **Collaborating and managing** Work independently, or collaboratively when required, considering resources and safety, to plan, develop and communicate ideas and information for solutions (WATPPS38) **Investigating and defining** Define a problem, and a set of sequenced steps,	measurement (ACMMG138) **Statistics and Probability** Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables (ACMSP147) Interpret secondary data presented in digital media and elsewhere (ACMSP148)

in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104) Processing and analysing data and information Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107) Evaluating Reflect on and suggest improvements to	Implement and use simple visual programming environments that include branching (decisions), iteration (repetition) and user input (ACTDIP020)	with users making decisions to create a solution for a given task (WATPPS33)	

scientific investigations (ACSIS108) Communicating Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)			

*Drawn from Design and Technologies and Digital Technologies curriculum

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Links to other curriculum areas

Humanities and Social Science (HASS)

- Decisions about the alternative use of resources result in the need to consider trade-offs (e.g. using the land to grow crops or to graze cattle) (ACHASSK149)
- Differences in the economic characteristics (e.g. per capita income, energy consumption), demographic characteristics (e.g. population size, density) and social characteristics (e.g. life expectancy, education) of a selection of countries across the world (ACHASSK139)
- Australia's connections with countries (e.g. trade, migration, tourism, aid, education, defence, sport) and how these connections change people and places (ACHASSK141)
- Identify current understandings, consider possible misconceptions and identify personal views on a topic (e.g. KWL chart, concept map) (WAHASS50)
- Develop and refine a range of questions required to plan an inquiry (WAHASS51)
- Locate and collect information and/or data from a range of appropriate primary sources and secondary sources (e.g. museums, media, library catalogues, interviews, internet) (WAHASS52)
- Use criteria to determine the relevancy of information (e.g. consider accuracy, reliability, publication date, usefulness to the question) (WAHASS55)
- Use decision-making processes (e.g. share opinions and personal perspectives, consider different points of view, identify issues, develop possible solutions, plan for action, identify advantages and disadvantages of different options) (WAHASS60)

- Reflect on learning, identify new understandings and act on findings in different ways (e.g. suggest additional questions to be investigated, propose a course of action on an issue that is significant to them) (WAHASS63)

English

- Participate in and contribute to discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions (ACELY1709)
- Plan, rehearse and deliver presentations, selecting and sequencing appropriate content and multimodal elements for defined audiences and purposes, making appropriate choices for modality and emphasis (ACELY1710)
- Select, navigate and read texts for a range of purposes, applying appropriate text processing strategies and interpreting structural features, for example table of contents, glossary, chapters, headings and subheadings (ACELY1712)
- Use comprehension strategies to interpret and analyse information and ideas, comparing content from a variety of textual sources including media and digital texts (ACELY1713)