Curriculum resource module

Pre-primary

Water flow

GOVERNMENT OF WESTERN AUSTRALIA
Department of Education
scitech
ECAWA
The Mathematical Association of Western Australia Inc.
STAWA SCIENCE TEACHERS' ASSOCIATION OF WESTERN AUSTRALIA

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The STEM Learning Project

The aim of the STEM Learning Project is to generate students' interest, enjoyment and engagement with STEM (Science, Technology, Engineering and Mathematics) and to encourage their ongoing participation in STEM both at school and in subsequent careers. The curriculum resources will support teachers to implement and extend the Western Australian Curriculum and develop the general capabilities across Kindergarten to Year 12.

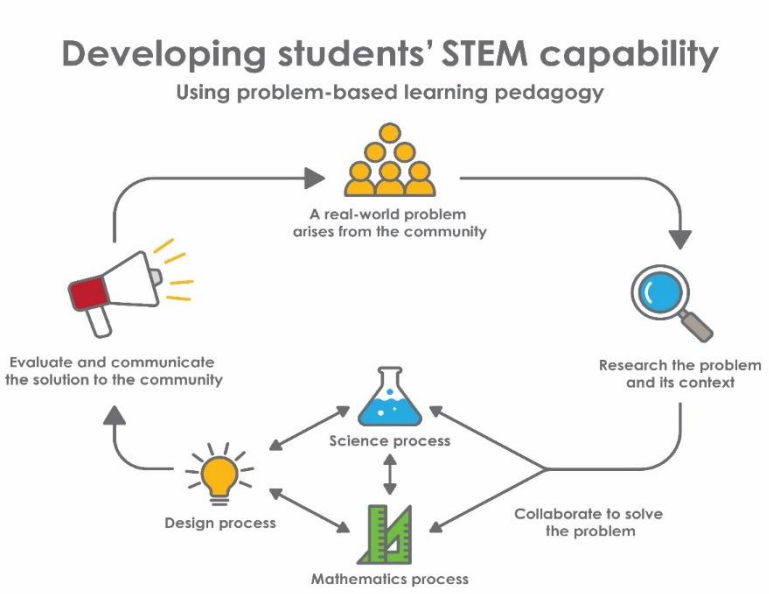
Why STEM?

A quality STEM education will develop the knowledge and intellectual skills to drive the innovation required to address global economic, social and environmental challenges.

STEM capability is the key to navigating the employment landscape changed by globalisation and digital disruption. Routine manual and cognitive jobs are in decline whilst non-routine cognitive jobs are growing strongly in Australia. Seventy-five per cent of the jobs in the emerging economy will require critical and creative thinking and problem solving, supported by skills of collaboration, teamwork and literacy in mathematics, science and technology. This is what we call STEM capability. The vision is to respond to the challenges of today and tomorrow by preparing students for a world that requires multidisciplinary STEM thinking and capability.

The approach

STEM capabilities are developed when students are challenged to solve open-ended, real-world problems that engage students in the processes of the STEM disciplines.



Pre-primary – Water flow

Overview

In this module, students discuss the importance of water and discover effective ways of transporting it to meet personal and community needs.

What is the context?

Access to water is vital for sustaining life. All humans, plants and animals need water, however, people may live long distances from water sources.

What is the problem?

How can we effectively transport water from a source to where it is needed?

How does this module support integration of the STEM disciplines?

Science

Science learning is addressed in *Activities 1* and 2. Students describe water sources, uses for water and ways in which water can be transported. They investigate, observe and describe how and why a marble will roll downwards (ACSSU005, ACSSU002).

Mathematics

Mathematics is addressed in *Activities 1* and 3. Students compare volumes, speeds and distances, and use mathematical language to describe these differences (ACMMG006, ACMMG010).

Technology

The Technologies curriculum is addressed in *Activities 1, 3* and *4*. Students analyse and annotate digital images to identify dams or other water sources in *Activity 1*and design, construct and evaluate a structure that can carry water over a distance in *Activities 3 and 4*.

The *Design process guide* is included as a resource to provide assistance to teachers in understanding the complete design process as developed in the technologies syllabus.

General capabilities

There are opportunities for the development of general capabilities and cross-curriculum priorities as students engage with *Water flow*. In this module, students:

- Develop problem solving skills as they research the problem and its context (*Activity1*); investigate parameters impacting on the problem (*Activity 2*); imagine and develop solutions (*Activity 3*); and evaluate and communicate their solutions to an audience (*Activity 4*).
- Utilise creative thinking as they generate possible design solutions; and critical thinking, numeracy skills and ethical understanding as they choose between alternative approaches to solving the problem.
- Utilise personal and social capability throughout the module as they collaborate in generating solutions; adopt group roles; and reflect on their group work capabilities.
- Utilise a range of literacies and information and communication technologies (ICT) capabilities as they make records of their work; and represent and communicate their solutions to an audience using digital technologies in *Activity 4*.

What are the pedagogical principles of the STEM learning modules?

The STEM Learning Project modules develop STEM capabilities by challenging students to solve real-world problems set in authentic contexts. The problems engage students in the STEM disciplines and provide opportunities for developing higher order thinking and reasoning, and the general capabilities of creativity, critical thinking, communication and collaboration.

The design of the modules is based on four pedagogical principles:

- Problem-based learning
  This is an underlying part of all modules with every module based around solving an initial problem. It is supported through a four-phase instructional model: research the problem and its context; investigate the parameters impacting on the problem; design and develop solutions to the problem; and evaluate and communicate solutions to an authentic audience.

- Developing higher order thinking
  Opportunities are created for higher order thinking and reasoning through questioning and discourse that elicits students' thinking, prompts and scaffolds explanations and requires students to justify their claims. Opportunities for making reasoning visible through discourse are highlighted in the modules with the icon shown here.

- Collaborative learning
  This provides opportunities for students to develop teamwork and leadership skills, challenge each other's ideas, and co-construct explanations and solutions. Information that can support teachers with aspects of collaborative learning is included in the resource sheets.

- Reflective practice
  Recording observations, ideas and one's reflections on the learning experiences in some form of journal fosters deeper engagement and metacognitive awareness of what is being learned. Information that can support teachers with journalling is included in the resource sheets.

These pedagogical principles can be explored further in the STEM Learning Project online professional learning modules located in Connect Resources.

Activity sequence and purpose

Activity 1

RESEARCH

Students discuss the importance of water and consider how it might be transported from a source to where it is needed.

Water transport race

Activity 2

INVESTIGATE

Students are challenged to move a marble as far as possible using ramps, exploring how angles and speed impact the distance a marble will travel.

Slopes and angles

Activity 3

IMAGINE & CREATE

Students create a marble run as a model for a water channel.

Students design, construct, test and improve their models.

Marble fun run

Activity 4

EVALUATE & COMMUNICATE

Students critique their designs, reflect on what they have learnt and communicate their findings to an audience.

Sharing findings

Background

Expected learning	At the completion of this module, students will be able to: 1. Describe some water sources and the uses for water. Identify some ways in which water is transported from sources to homes. 2. Investigate, observe and describe how a marble will roll downwards. 3. Use mathematical language to describe differences in volumes, speeds and distances. 4. Analyse *Google Earth* maps to identify features such as dams and towns. 5. Design, construct and test a structure to carry marbles from one point (the source of water) to another (where the water will be used) and explain how it could carry water. 6. Work efficiently in collaborative learning situations to generate a solution.
Vocabulary	There are opportunities during the module to develop the following vocabulary: around, behind, between, channel, curves, dam, design, down, far, farther, farthest, force, forward, in front, long, longer, longest, narrower, next to, on top, ramp, roll, shape, size, slope, smooth, steep, steeper, steepest, straight, taller, underneath, A free positional language word wall can be downloaded at *www.twinkl.co.uk/resource/t-l-096-positional-language-word-cards (Twinkl, 2017)*
Timing	There is no prescribed duration for this module. The module is designed to be flexible enough for teachers to adapt. Activities do not equate to lessons; one activity may require more than one lesson to implement.
Consumable materials	A *Materials list* is provided for this module. The list outlines materials outside of normal classroom equipment that will be needed to complete the activities.

Safety notes	There are potential hazards inherent in these activities and with the equipment being used, and a plan to mitigate any risks will be required. Potential hazards specific to this module include but are not limited to: • cyber bullying and online privacy and protection.
Assessment	The STEM modules have been developed to provide students with learning experiences to solve authentic real-world problems using science, technology, engineering and mathematics capabilities. Appendix 1 indicates how the activities are linked to the Western Australian Curriculum. Evidence of learning from journalling, presentations and anecdotal notes from this module can contribute towards the larger body of evidence gathered throughout a teaching period and can be used to make on-balance judgements about the learning demonstrated by the students in the science, technologies and mathematics learning areas. Students can further develop the general capability of Personal and social capability. A *General capabilities continuum* is included but is not intended for assessment purposes.

Activity 1: Water transport race

Activity focus 	Students discuss the importance of water and consider how it might be transported from a source to where it is needed. Students are introduced to the importance of transporting water in our everyday lives and the lives of others (eg farmers, people in developing countries). To experience how water transportation by hand leads to the loss of water, time and human energy. Students take part in a water race.
Background information	Humans have basic needs including shelter, food and water. Water is needed for drinking, cooking, washing and for animals and plants. The ultimate source of water is rainfall which can be collected in dams or water tanks or flow into rivers. In developed countries like Australia, it is common for water to be gravity fed in pipes from dams or tanks to houses. In many developing countries access to water is limited. It is often the responsibility of women and children to walk long distances to collect water and carry it to their homes each day. Sometimes children cannot go to school because they have to fetch water for the family. The World Vision video *Walking in Sabina's Shoes* illustrates the impact of water carrying on women's lives.
Instructional procedures	Information on the significance of Western Australian water ways and Aboriginal culture. *www.water.wa.gov.au/__data/assets/pdf_file/0007/3211/85861.pdf*
Expected learning	Students will be able to: 1. Describe some sources and uses for water and ways in which water is transported (Science). 2. Analyse *Google Earth* maps to identify features such as dams and towns (Mathematics). 3. Compare volumes and use mathematical language to describe differences (Mathematics).

Equipment required	**For the class:** Class reflective journal Interactive whiteboard *Google Earth* Map of the school Digital camera Masking tape Water
	For the students: Buckets or large plastic containers of equal size Smaller containers for carrying water (eg yoghurt containers)
Preparation	To engage students in the concept of water, *The Wonder Thing* (Libby Hathorn, 1995) could be read prior to the lesson. Preview the *Walking in Sabina's Shoes* video and determine how much of the video to share with students. The video is thirteen minutes long, however many ideas are presented in the first seven minutes. Load *Google Earth* and locate local dams. Collect and prefill containers for the water race and identify a suitable location for the race. It is suggested to send a parent letter informing them about the STEM activity students will be undertaking. Explain the duration of the activities, the resources and materials that will be required as donations, and the times when parent help will be required. See *Teacher resource sheet 1.3: Sample parent letter*. Create a space accessible to students in the classroom for a word wall. Add new science, mathematics, and technology and context specific language as it is encountered. Students will need scaffolding around how to interpret maps. Storage will be needed to be provided for collected materials.

Activity parts

Part 1: Investigating water sources

As a class, discuss the importance of water. Brainstorm and create a class mind map.

Questions could include:

- Why is water important?
- How do we use water?

Take the students on a tour of the school to locate various water points. Encourage students to take photos of water points. Print and display photos or plot them on a map of the school.

Examine *Google Earth*. Begin at the school and zoom out to find the nearest dam.

Ask students to predict how the water supplies are connected:

- How does water travel from its source to our taps?

Explain that some places do not have water pipes. Discuss how people get their water if there are no pipes.

As a class, watch the World Vision video *Walking in Sabina's Shoes* to illustrate how a woman in a developing country travels each day to collect and carry water for her family.

Part 2: Water race

Explain to the students that they are going to have a water race. Organise students into relay teams. Each team will need one full bucket of water at one end of the race and an empty bucket on the opposite end. They will also need small containers to transport the water.

Mark the water level of the full bucket with masking tape to demonstrate how full it is at the beginning of the race. Each team will compete to transfer the water from their full bucket to the empty bucket using the small containers. Taking turns, team members will run to fill the empty container and return to tag the next student in their team.

The race will continue until each bucket that was originally full of water is empty. Students will need to consider speed versus care, an open or closed container etc. The race may be run a second time after discussion of these considerations. Students will also need to determine the criteria for a winning team, would it be time or efficiency?

Part 3: Water levels

At the end of the race, pour each team's water back into the original buckets and mark the new water level.

Compare the original and final water levels to determine how much water was lost.

- How has the water level changed?
- Is there more water or less water after the race?
- Where has the water gone?
- Describe how the water levels are different between the teams? Why are the water levels different?

Part 4: Class discussion

Back in the classroom, discuss what happened in the water race.

- Which team was the fastest? Why were they so fast?
- Which team saved the most water? How do you know?
- Why is wasting water a problem?
- Was it a fair race?
- Why would Sabina need to save water?
- Do you think carrying water by hand works well? Why and why not?

If we had to collect water by hand would we have time to come to school or do other activities? How would this impact us?

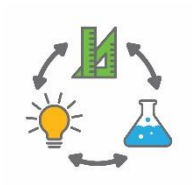
Part 5: Journalling

An A3 class floor book could be created to record student learning and act as the first steps towards journalling. This would be created by the teacher or teacher assistant and look like photos of students working together on the activities, along with annotations to capture thinking. Refer to *Reflective journal* for elaborations.

A digital alternative is to use an app to create a journal (eg *Kidblog, Explain everything, Keynote, iBook)*. The digital version could be uploaded to an app of choice, such as *Seesaw* or *Connect* to share learning with the parent community.

Digital resources	*Walking in Sabina's Shoes* (World Vision, 2010) *www.youtube.com/watch?v=-bEtqZoD4V4*
	Seesaw *web.seesaw.me*
	Connect – the DoE portal for teachers *connect.det.wa.edu.au*
	Kidblog *kidblog.org/home*
	Explain everything *explaineverything.com*
	Keynote *www.apple.com/au/keynote/*
Resource sheets	*Teacher resource sheet 1.3: Sample parent letter*
Literary resources	*The Wonder Thing* (Libby Hathorn, 1995)

Activity 2: Slopes and angles

Activity focus 	Students are challenged to move a marble as far as possible using ramps, exploring how angles, slope and speed impact the distance a marble will travel. This exercise connects how water travels from dams to our houses.
Background information	Scientists often use models to investigate phenomena as this can be more efficient and convenient than testing in the real world. In this activity, students work with marbles to model the movement of water. On a level surface a marble must be pushed in order to move; the push force overcomes the inertia of the marble. When a marble is placed on a slope, the Earth's gravitational pull causes the marble to roll in the same way that water flows downhill. The gradient of a slope impacts the movement of a marble. The steeper the slope, the faster a marble will roll downward. If the slope is too steep, the marble will fall and may not travel far once it hits the ground. The key variables which affect the roll of a marble are its shape, the texture of its surface, and the angle and friction between the marble and the slope.
Instructional procedures	Students will work in small groups and may respond well to assigned team roles within their groups (see *Teacher resource sheet 1.1: Cooperative learning – Roles*). As students build ramp structures there will be many opportunities to integrate vocabulary. Students may use positional language as they negotiate the use of materials with team members (on top of, underneath, in front of, behind, next to, between). They may use movement vocabulary to explain to a peer how their marble travels on their design (roll, down, forwards, around, curves, straight). Students can use measurement vocabulary to describe how far their marble travelled in comparison to other teams (far, farther). They may connect the distance travelled by the marble to the length and gradient of a slope (long, longer, longest, steep, steeper, and steepest).

	Questioning can be used to guide students as they predict, test, measure and then communicate their findings. Example questions include: **Predict:** What do you think will happen if you make the slope steeper, narrower or taller? **Test:** What happened after you made changes? Did it improve your marble run to make your marble go further? Why or why not? **Measure:** How far did your marble run? How can you measure this?
Expected learning	Students will be able to: 1. Investigate, observe and describe the conditions under which a marble will roll over a long distance (Science). 2. Use every day language to describe the differences in speeds and distances rolled by marbles under different conditions (Mathematics).
Equipment required	**For the class:** Class reflective journal Interactive whiteboard and internet access Coloured string or streamers Large sticky notes
	For the students: A marble A variety of materials such as wooden blocks, planks, card, cardboard tubes, paper streamers.
Preparation	In the weeks leading up to this activity, collect materials for students to create their designs. Prepare the classroom by arranging furniture to create appropriate space for students to build their marble runs. Students may wish to attach their marble runs to furniture.
Activity parts	**Part 1: Investigating materials and angles** Through whole class discussion, review learning from *Activity 1* about the need to move water from a source to people's homes.

Explain to the students that they will investigate and model the movement of water by designing and building structures to move a marble as far as they can without pushing it. Discuss why marbles will be used instead of water.

Show students the materials available and allow time for them to design, build, share and test their ideas. After the groups have explored how to maximise the roll of their marble, each team will use a streamer to measure how far their marble travelled. This does not include the ramp. Cut the streamer to the correct length representing the distance travelled. Label streamers with each group's name and measure lengths in centimetres.

Lay the streamers on the floor to make a 'column' graph and ask the students to compare the lengths.

- Which streamer is the longest?
- Why did this marble travel so far?
- Which streamer is the shortest?
- Why did this marble not travel far?

Ask the students:

- What do you need to do to make the marble roll the furthest? Why?

Explore reasoning with the prompt: *Because…*

Part 2: Ramps

Use a search engine to search for 'ramps' and click on some images to observe, analyse and discuss. Involve the students in the searching process to build student capacity. Through a think, pair, share activity students discuss the following questions (*Teacher resource sheet 1.2: Cooperative learning – Think, Pair, Share*).

- Why do we use ramps?
- What are some different ramps you have seen? (eg rollercoaster, skate park, wheelchair ramps, stream flowing downhill)

Model a ramp using a piece of card and a marble. Demonstrate by lifting one side of the card to make the marble move. Discuss how the spherical shape of the marble enables it to roll. Model positional language to describe how the card and marble are moving. Prompt students to recognise that things roll or slide downwards on ramps.

Questions could include:

- How do all of these ramps work?
- Which way do things move on these ramps? Why?
- Could we use a ramp to transport water to our homes? Why?

Record students' answers in the class reflective journal.

Additional learning experiences: Marble painting

This activity could be undertaken to further develop the mathematic concept of angles and slopes. Students could predict patterns based on how they think the marbles will roll.

Materials:

Marbles

Activity paint

Muffin tin, egg carton or small bowls to hold paint

Spoons

Paper

Shallow cardboard box (A4 photocopy paper box lid) or a baking dish lined with white paper

Steps:

1. Drop the marbles in the paint colour of choice.
2. Mix them around to coat them with paint then transfer them to the cardboard box.
3. Lift and tilt the cardboard box to move the marbles around, leaving paint trails behind.

Alternatively, squeeze the paint directly into the cardboard box lid.

Part 3: Journalling

With assistance, students draw and label their marble run on a sticky note to go into the class reflective journal. Record each team's distance next to the sticky notes.

Add digital photos to the class reflective journal and scribe students' comments to record the thinking process behind their designs.

Resource sheets	*Teacher resource sheet 1.1: Cooperative learning – Roles* *Teacher resource sheet 1.2: Cooperative learning – Think, Pair, Share*
Digital resources	Positional language word wall *www.twinkl.co.uk/resource/t-l-096-positional-language-word-cards (Twinkl, 2017)*

Activity 3: Marble fun run

Activity focus 	Students create a marble run as a model for a water channel. Students design, construct, test and improve their models.
Background information	This activity engages students in an engineering design process to develop, produce and evaluate a model of a structure that could be used to transport water. Marbles are used to model the flow of water in the same way that engineers use models in designing and testing structures. Engineers must first analyse and understand the problem, imagine possible approaches, plan what will be done, design the structure, test and improve the structure, and then document and communicate their solution to the client. The key principle that should inform the design is that water will naturally flow downwards under its own weight. The structure should therefore have a continuous downward slope from source to home. Given that it is often not possible to build a water channel in a straight line, the design needs to allow for the water to flow around bends without spilling from the channel.
Instructional procedures	Students will need assistance with cutting and joining skills. Parent help or buddy class support will need to be arranged. See *Teacher resource sheet 4.2: Construction skills*. Decide how materials will be shared and distributed among students and if each team will receive the same materials. Alternatively, allow each team to have a certain number of materials that they can choose.
Expected learning	Students will be able to: 1. Design, construct and test a structure to carry marbles from one point (the source of water) to another (where the water will be used) (Technologies).

Equipment required	**For the class:** Class reflective journal Interactive whiteboard with internet Variety of recycled materials of different shapes, colours, sizes and textures Construction materials as outlined in *Appendix 3*
	For the students: Variety of cardboard tubing Masking tape Scissors Egg cartons Shoe boxes Pre-cut paper plates (these need to have a curved edge that a marble can roll in) Plastic straws Paper cups Hollow pool noodles cut lengthwise Moulding and tubing Construction paper for securing towers
Preparation	Decide on the scale of the structures the students will build and the distances over which the marbles will run as this will determine the types and quantity of materials required. The marble runs could be one to two metres long or as short as a track glued onto the back of a shoebox lid. Organise work spaces for students to create solutions, ensuring easy access of construction materials. Small group rotation activities may be the best way to accommodate for this, with one adult at each table of three to four students. *Teacher resource sheet 4.2: Construction skills* provides a scaffold for developing construction skills and is suggested to be displayed in an area accessible to students. **Additional learning experience:** Students could use plasticine to create water channels on a water play table and use watering cans to observe water flow.

Activity parts

Part 1: Researching water transportation

Review the variables (eg gradient, material, length) that influenced the distance moved by the marbles in *Activity 2*. Discuss how these apply to the transport of water.

Watch videos showing examples of how we transport water in Western Australia (Mundaring Weir and the Golden Pipeline), and the video showing how an ancient civilisation (Machu Picchu) transported and controlled the flow of water using water channels.

Discuss the importance of sustainability and conserving water.

Part 2: Design

Explain to students that they are going to design, construct and test a model of a structure that could be used to transport water. Marbles will be used to model the flow of water. The model must safely transport a marble over a stated distance to a destination (paper bowl or cup) and have at least one bend in the path.

Ask students how they will work as a team and how they will choose ideas.

Provide students with time to discuss designs, how they would make the model and the materials they will use. As a class, share ideas in a brainstorming session before groups finalise their plans and start construction work.

Part 3: Construct

Students begin constructing their marble runs. *Teacher resource sheet 4.2: Construction skills* is a useful resource for this activity.

As students are completing their design, ask them to explain their ideas:

- Where will it start and finish?
- Why is this end higher?
- How do you plan to make a bend in the marble run?
- How will you join your materials?
- How will you stop your marble falling out of your marble run?

If a group is experiencing difficulty, ask:

- What is not working? Why?
- How can you fix it?

Encourage teamwork and persistence.

Take digital photos to document the students' work.

Students are encouraged to follow the *Design process guide* throughout their work, seeking and applying feedback at any stage to enhance their solution. These refinements should be captured on camera along with student thinking and justifications. Anecdotal notes can be recorded using *Teacher resource sheet 3.1: Prototype troubleshooting*.

Part 4: Test

Test each marble run to see if it delivers a marble safely to a destination. Talk about each test being fair by using the same marble and releasing it at the top, not pushing it.

After each attempt guide student thinking through questioning to evaluate the success of their solution. Practice wait time and encourage deeper thinking, using *because* and *why* as prompts:

- Did your solution deliver the marble to the destination? Why or why not?
- Is there anything you would change? *Because*…
- What worked well on your design? *Because*…

Asking these questions will give students an opportunity to critically analyse their work, further engaging them with the design process.

Students take turns to show their work and describe the thinking behind their design. Encourage the development of cooperative skills such as listening and taking turns to talk when sharing. Discuss whole body listening and how it is important to show respect when others are talking.

After each presentation ask students to give verbal feedback on what they found interesting about each team's design. Record the experiences in the class reflective journal or on sticky notes.

Note: Students do not have to apply the change but should be given the opportunity for feedback and making informed decisions. This will encourage teamwork and interaction.

Resource sheets	*Teacher resource sheet 3.1: Prototype troubleshooting* *Teacher resource sheet 4.2: Construction skills*
Digital resources	*Marble run* (STEM Projects, 2014) *www.youtube.com/watch?v=fDilfPD52QQ*
	Mundaring Weir Western Australia (Andy Ballard, 2016) *www.youtube.com/watch?v=5Qfqq_GRHG0*
	Golden Pipeline Trail (theatretwitt, 2011) *www.youtube.com/watch?v=SAGsPOSGMpA*
	Machu Picchu Water Management System (Randy A, 2014) *www.youtube.com/watch?v=9hlg2sYN0yY* Please note the dialogue in this video will be difficult for the students to understand. It is suggested that the teacher commentates while watching the video on mute.

Activity 4: Sharing our findings

Activity focus 	Students critique their designs, reflect on their learning and communicate their findings to an audience.
Instructional procedures	Students engage in reflection, evaluation and communication of their thinking about how their model works. Students think about how the design was changed for improvements and the scientific basis of the design (ie that the channel has to have a downward slope to allow the marble or water to roll down under the influence of gravity).
Expected learning	Students will be able to: 1. Explain how marbles roll and water will flow down a slope from the source to where it can be used (Science). 2. Evaluate a structure designed to carry water over a distance (Technologies).
Equipment required	**For the class:** Class reflective journal
	For the students: Pencils Photo of their group's model and design solutions from *Activity 3*
Preparation	For each student, print out a picture of their group's model, ensuring there is enough white space to annotate the photo. Alternatively, provide materials for students to draw and label their design, identifying the slope and channels. Invite a suitable audience such as a plumber or a Water Corporation representative, to listen to the students' evaluation.

Activity parts

Part 1: Class reflection

Through whole class discussion, reflect on *Activity 3*. Discuss problems groups encountered and how students solved these problems.

Did they follow the design process by testing and making modifications?

Revisit vocabulary students developed from *Activity 1* (eg channel, pipe and slope). Is there any new vocabulary to add?

Part 2: Group reflection

Provide each student with a photo of their model.

Encourage students to draw a face to indicate how they felt about the design (eg happy, unsure or sad). This is an opportunity to assess each student's ability to engage in the design process and to evaluate the success of their design.

Ask the students if they had any problems with their design and ask them to explain the solution they found. Record answers in the class reflective journal or use a digital device.

Suggested questioning prompts:

- Why did the marble roll along your model?
- What part of your model worked?
- What part of your model didn't work? Why? How was it fixed?
- Which group's design worked best? How do you know?

Collate group's data using an app of choice to show the learning journey the children have experienced. This can be shared with the parent community using a digital platform such as *Connect*.

Reflect on student learning using *Teacher resource sheet 4.1: 3 – 2 – 1 – Reflection*.

Part 3: Journalling

Review the module using the class reflective journal to promote discussions. Begin by asking the class what they learnt and add these answers to the class's brainstorm from *Activity 1*.

	Use a different coloured pen or different coloured sticky notes to distinguish what they have learnt from prior knowledge. Ask the students what they have enjoyed about the activities. Ask the students to reflect on how well they have worked in groups. Encourage students to: • Explain their learning journey. • Explain the IT tools used. • Explain thinking and demonstrate solution.
	Part 4: Take it outside Students could take their model water channels outside and pour water down them to see how they work. Note that this may damage their structures if not made with waterproof materials.
Additional learning experience	Excursion or incursion related to the work of the Water Corporation or Mundaring Weir.
Resource sheets	*Teacher resource sheet 4.1: 3 – 2 – 1 – Reflection*

Appendix 1A: Links to the Western Australian Curriculum

The *Water flow* module provides opportunities for developing students' knowledge and understandings in science, technologies and mathematics. The table below shows how this module aligns to the content of the Western Australian Curriculum and can be used by teachers for planning and monitoring.

WATER FLOW Links to the Western Australian Curriculum	ACTIVITY			
	1	**2**	**3**	**4**
SCIENCE				
SCIENCE UNDERSTANDING				
Physical sciences: The way objects move depends on a variety of factors, including their size and shape (ACSSU005)	●			
Biological sciences: Living things have basic needs, including food and water (ACSSU002)	●			
DESIGN AND TECHNOLOGIES				
PROCESS AND PRODUCTION SKILLS				
Designing: Generate and record design ideas through describing, drawing, modelling and/or a sequence of written or spoken steps.			●	
Producing and implementing: Use given components and equipment to safely make simple solutions.		●	●	
Collaborating and managing: Work independently, or with others when required, for solutions.	●	●	●	●
MATHEMATICS				
MEASUREMENT AND GEOMETRY				
Using units of measurement: Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language (ACMMG006)	●	●		

Further information about assessment and reporting in the Western Australian Curriculum can be found at: *https://k10outline.scsa.wa.edu.au/home*

Appendix 1B: Mathematics proficiency strands

Source:
www.australiancurriculum.edu.au/f-10-curriculum/mathematics/key-ideas/?searchTerm=key+ideas#dimension-content

Key ideas

In Mathematics, the key ideas are the proficiency strands of understanding, fluency, problem-solving and reasoning. The proficiency strands describe the actions in which students can engage when learning and using the content. While not all proficiency strands apply to every content description, they indicate the breadth of mathematical actions that teachers can emphasise.

Understanding

Students build a robust knowledge of adaptable and transferable mathematical concepts. They make connections between related concepts and progressively apply the familiar to develop new ideas. They develop an understanding of the relationship between the 'why' and the 'how' of mathematics. Students build understanding when they connect related ideas, when they represent concepts in different ways, when they identify commonalities and differences between aspects of content, when they describe their thinking mathematically and when they interpret mathematical information.

Fluency

Students develop skills in choosing appropriate procedures; carrying out procedures flexibly, accurately, efficiently and appropriately; and recalling factual knowledge and concepts readily. Students are fluent when they calculate answers efficiently, when they recognise robust ways of answering questions, when they choose appropriate methods and approximations, when they recall definitions and regularly use facts, and when they can manipulate expressions and equations to find solutions.

Problem-solving

Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively. Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable.

Reasoning

Students develop an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising. Students are reasoning mathematically when they explain their thinking, when they deduce and justify strategies used and conclusions reached, when they adapt the known to the unknown, when they transfer learning from one context to another, when they prove that something is true or false, and when they compare and contrast related ideas and explain their choices.

Appendix 2: General capabilities continuum

Personal and social capability learning continuum

Organising element	Level 1A students	Typically by the end of Foundation Year, students
Self-awareness element		
Recognise emotions	recognise and identify their own emotions	identify a range of emotions and describe situations that may evoke these emotions
Recognise personal qualities and achievements	express a personal preference	identify their likes and dislikes, needs and wants, and explore what influences these
Understand themselves as learners	select tasks they can do in different learning contexts	identify their abilities, talents and interests as learners
Develop reflective practice	recognise and identify participation in or completion of a task	reflect on their feelings as learners and how their efforts affect skills and achievements
Self-management element		
Express emotions appropriately	recognise and identify how their emotions influence the way they feel and act	express their emotions constructively in interactions with others
Develop self-discipline and set goals	make a choice to participate in a class activity	follow class routines to assist learning
Work independently and show initiative	attempt tasks with support or prompting	attempt tasks independently and identify when and from whom help can be sought
Become confident, resilient and adaptable	identify people and situations with which they feel a sense of familiarity or belonging	identify situations that feel safe or unsafe, approaching new situations with confidence

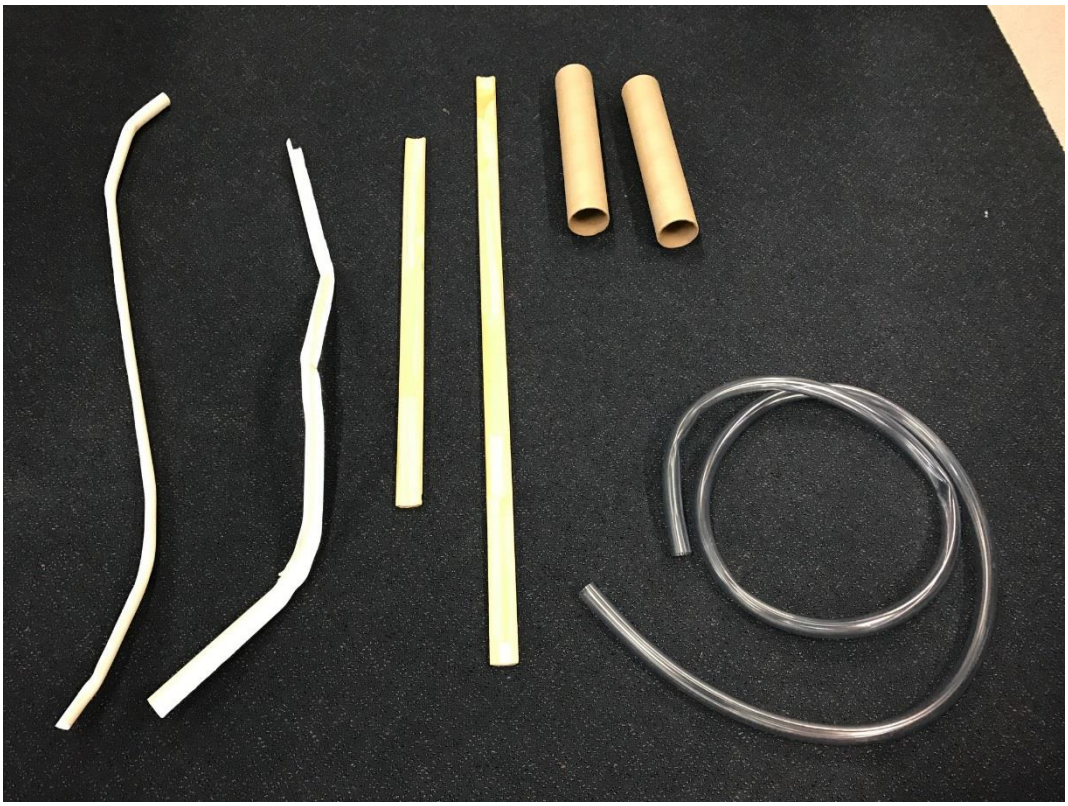
Social awareness element		
Appreciate diverse perspectives	show an awareness for the feelings, needs and interests of others	acknowledge that people hold many points of view
Contribute to civil society		describe ways they can help at home and school
Understand relationships		explore relationships through play and group experiences
Communicate effectively	respond to the feelings, needs and interests of others	identify positive ways to initiate, join and interrupt conversations with adults and peers
Work collaboratively		share experiences of cooperation in play and group activities
Make decisions		identify options when making decisions to meet their needs and the needs of others
Negotiate and resolve conflict		listen to others' ideas, and recognise that others may see things differently from them

Further information about general capabilities is available at:
k10outline.scsa.wa.edu.au/home/p-10-curriculum/general-capabilities-over/general-capabilities-overview/general-capabilities-in-the-australian-curriculum

Appendix 3: Materials list

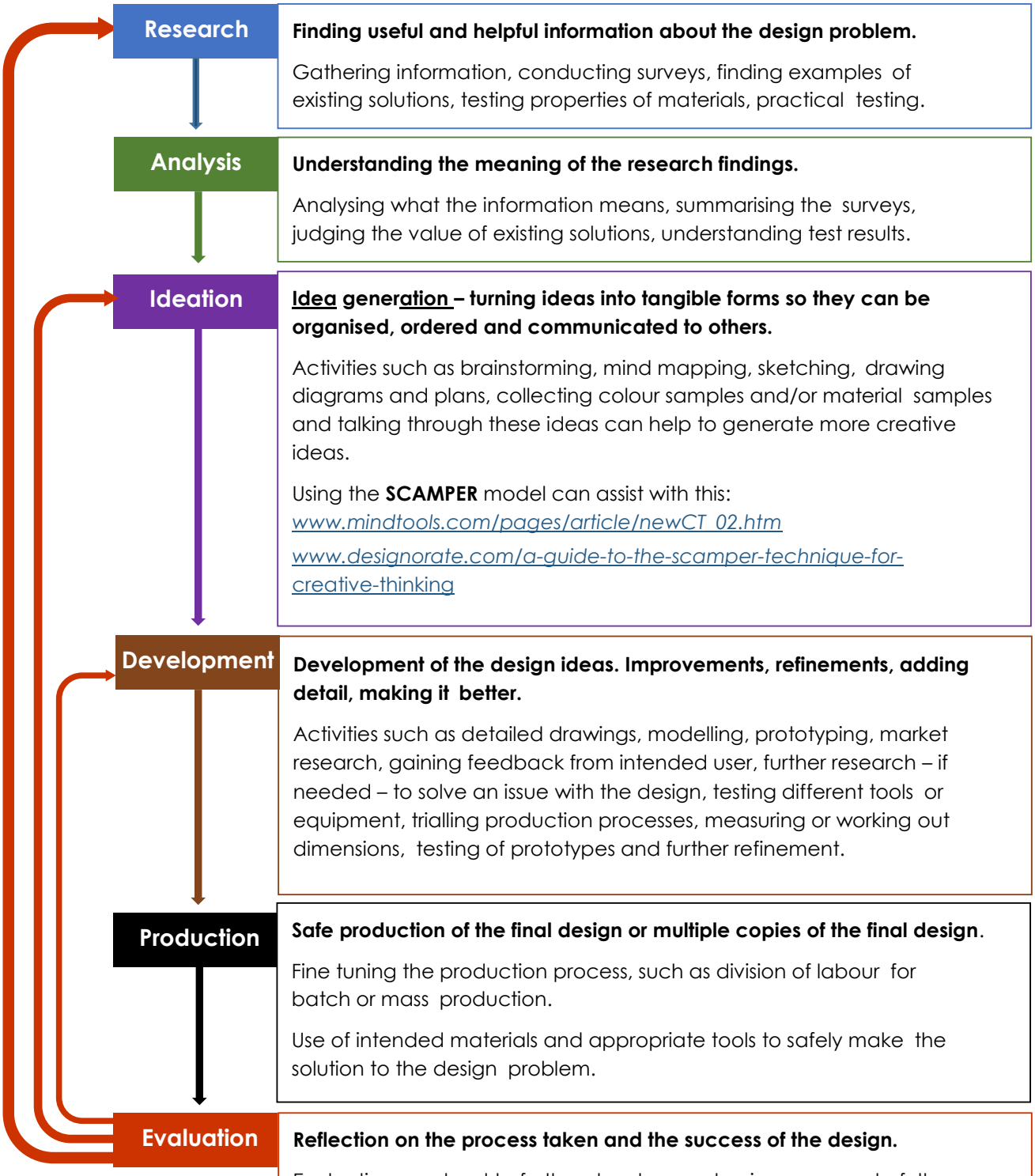
Materials needed for this module:

- class reflective journal
- interactive whiteboard with access to *Google Earth* or similar
- masking tape
- access to water
- six buckets or large plastic containers of equal size
- three smaller containers for carrying water (eg yoghurt containers)
- lengths of coloured streamers
- a variety of loose parts such as wooden blocks, pre-cut pool noodles, moulding and tubing
- a variety of cardboard tubing, scissors, egg cartons, shoe boxes, pre-cut paper plates (these need to have a curved edge that a marble can roll in), plastic straws, paper cups and construction paper
- marbles.



An example of materials students may use to create their models

Appendix 4: Design process guide



Appendix 5: Reflective journal

When students reflect on learning and analyse their own ideas and feelings, they self-evaluate, thereby improving their metacognitive skills. When students self-monitor or reflect, the most powerful learning happens.

Journalling may take the form of a written or digital journal, a portfolio or a digital portfolio. Early childhood classrooms may use a class reflective floor book with pictures of the learning experience and scribed conversations.

Teachers can model the journalling process by thinking aloud and showing students how they can express learning and thoughts in a variety of ways including diagrams, pictures and writing.

Journals are a useful tool that gives teachers additional insight into how students value their own learning and progress, as well as demonstrating their individual achievements.

The following links provide background information and useful apps for journalling.

Kidblog – digital portfolios and blogging *kidblog.org/home*
Edmodo – for consolidating and storing class notes and learning materials *www.edmodo.com/*
Explain Everything™ – a screen casting, video and presentation tool all in one *explaineverything.com*
Popplet – allows you to jot down your ideas and then sort them visually *Popplet.com*
Seesaw – for capturing work completed by students in class, using a device's camera function *web.seesaw.me*
Connect – the DoE portal for teachers *connect.det.wa.edu.au*
Evernote (a digital portfolio app) *evernote.com*
Digital portfolios for students (Cool tools for school) *cooltoolsforschool.wordpress.com/digital-student-portfolios*

Appendix 6: Teacher resource sheet 1.1: Cooperative learning – Roles

Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

When students are working in groups, positive interdependence can be fostered by assigning roles to group members.

These roles could include:

- working roles such as Reader, Writer, Summariser, Time-keeper.
- social roles such as Encourager, Observer, Noise monitor, Energiser.

Teachers using the *Primary Connections* roles of Director, Manager and Speaker for their science teaching may find it effective to also use these roles for STEM learning.

Further to this, specific roles can be delineated for specific activities that the group is completing.

It can help students if some background to the purpose of group roles is made clear to them before they start, but at no time should the roles get in the way of the learning. Teachers should decide when or where roles are appropriate to given tasks.

Appendix 7: Teacher resource sheet 1.2: Cooperative learning – Think, Pair, Share

This resource sheet provides a brief outline of a cooperative learning strategy known as 'think – pair – share'.

Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

In the 'think' stage, each student thinks silently about a question asked by the teacher.

In the 'pair' stage, students discuss their thoughts and answers to the question in pairs.

In the 'share' stage, the students share their answer, their partners answer or what they decided together. This sharing may be with other pairs or with the whole class. It is important also to let students 'pass'. This is a key element of making the strategy safe for students.

Think – pair – share increases student participation and provides an environment for higher levels of thinking and questioning.

Appendix 8: Teacher resource sheet 1.3: Sample parent letter

(School details and letterhead)

(Date)

Dear parents/caregivers,

RE: COLLECTION OF RECYCLABLE ITEMS FOR *OUR WATER FLOW* STEM PROJECT

This term, our class is undertaking a STEM (Science, Technology, Engineering and Mathematics) project called *Water flow*. This project will involve students in our class discussing the importance of water and discovering effective ways of transporting it to meet personal and community needs.

This project focuses on repurposing recyclable items in an effort to give students opportunities to consider sustainability and the impact of our lifestyles on our environment, whilst developing their ability to design, create and problem-solve. To enable us to create *Water flow* solutions, we would appreciate if you could please collect clean recyclable items from your house and send them to school with your child. Please do not include any glass or toilet rolls.

We will be starting the project on (date), and would like the recyclable items to be delivered to the classroom before this.

We will be discussing the shape and material properties of the recyclable items before using them to create our solutions. We may require adult assistance during the construction phase so please let me know if you are available to help.

Thank you in advance,

(Classroom teacher)

Appendix 9: Teacher resource sheet 3.1: Prototype troubleshooting

Student's name	Problem	Reason for the problem	Possible changes to your design to solve the problem
Ariana	The marble falls out on the bends	The sides aren't high enough	Increase the size of ramp sides

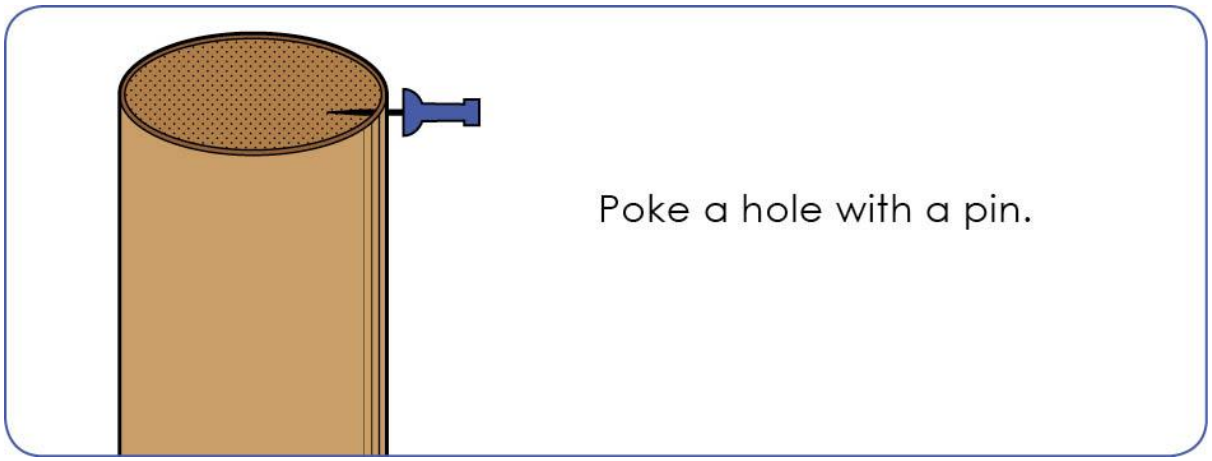
Appendix 10: Teacher resource sheet 4.1: 3 – 2 – 1 – Reflection

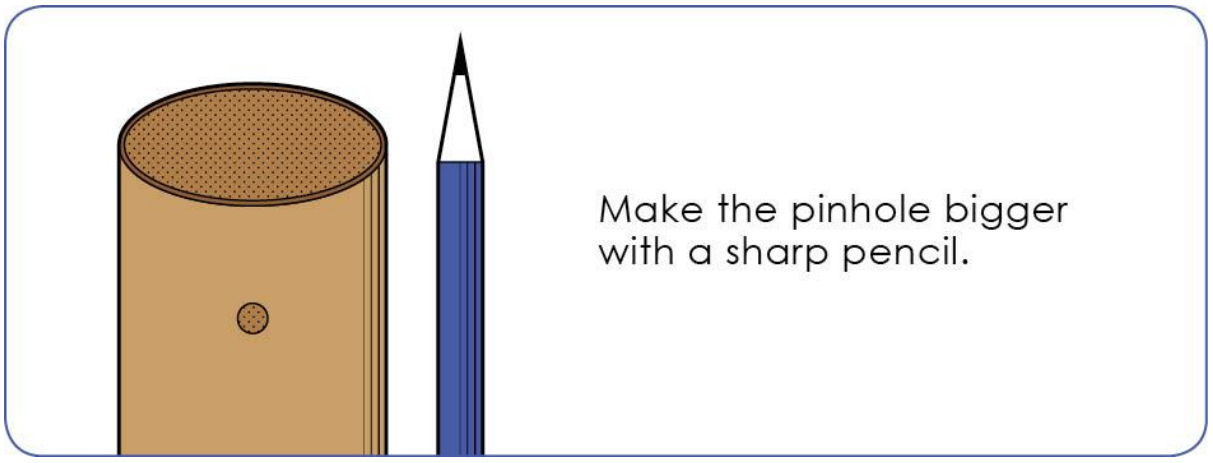
3 – 2 – 1 – Reflection			
Name	**3 things they learnt**	**2 things they found interesting**	**1 thing they found difficult**

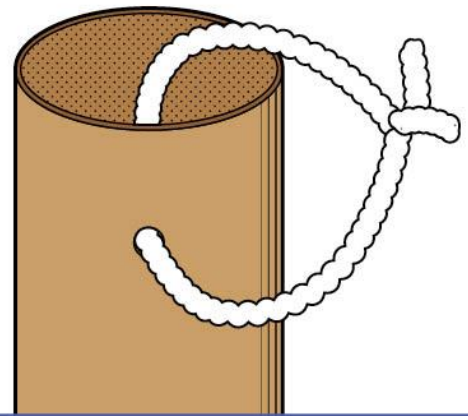
Appendix 11: Teacher resource sheet 4.2: Construction skills

Construction skills help students to generate and produce solutions for real-world problems. This resource develops students' skills in design and technologies.

This resource can be used as a visual stimulus to prompt students to develop solutions to design problems. The cards can be printed out to create stations.

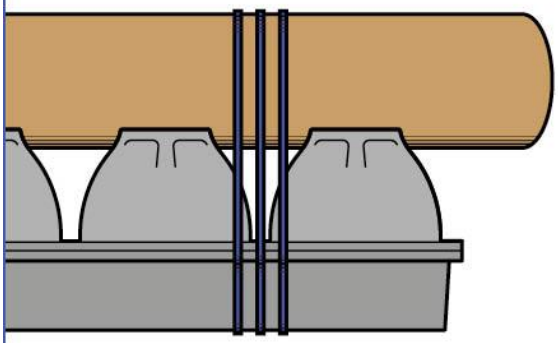




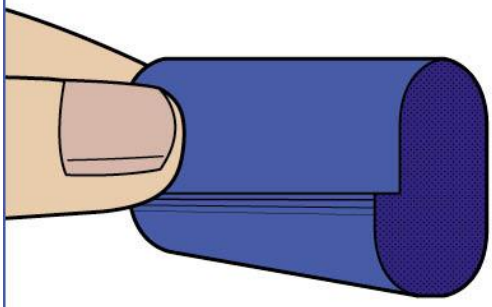


Make a loop using a pipe cleaner.

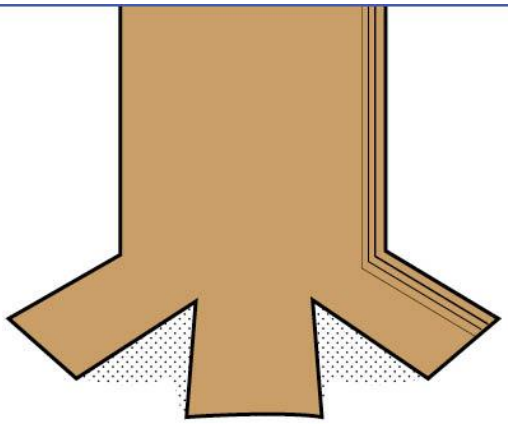
Use a paper binder to fasten objects together.



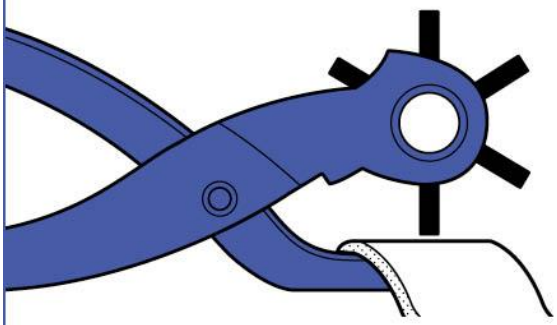
Use cable ties to tie objects together.



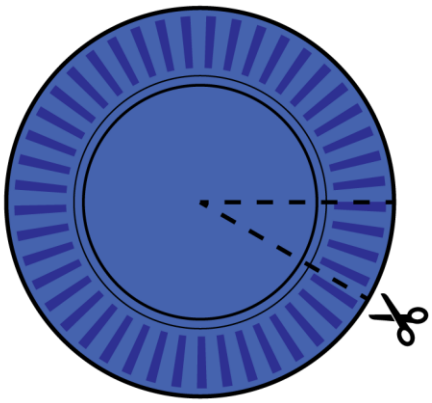
Make a tape loop with
the sticky side on the outside.



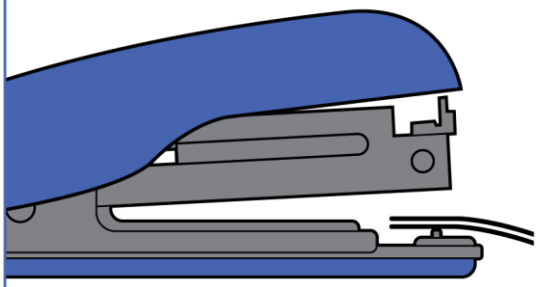
Cut the end of a tube into a
fan to attach it to a flat object.



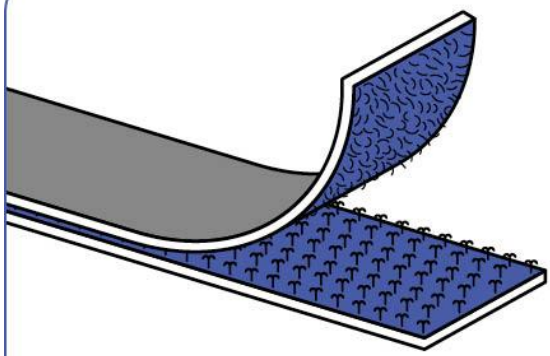
Use a leather hole punch
to make holes in objects.



Cut a sector out of a paper plate, and join the edges to make a cone shape.



Use a stapler to join materials together.



Use velcro to join objects.

Notes