Exploring Surface Water Tension and Water Striders

_Masters of Teaching (Primary Education) Science in Primary Education (ETP5007) ~ Exploring Surface Water Tension and Water Striders

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VICTORIA UNIVERSITY

WATERWATCH Victoria

river DETECTIVES

Melbourne Water

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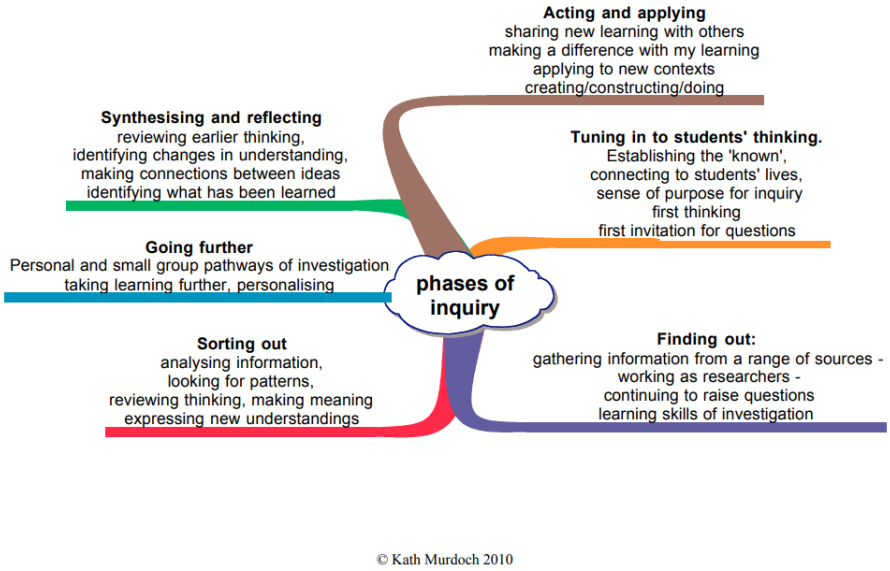
Appendices…

Executive Summary

Overview of the Unit of Work

When considering which project to undertake we considered the curriculum resources available to us, possible research and evaluation techniques, and the ease with which future teachers could incorporate Indigenous perspectives into these lessons plans.
We used an inquiry-based approach using the 5es as a template from Primary Connections as well as Kath Murdoch's phases of inquiry; (https://www.kathmurdoch.com.au/new-page-2-1 2010). We aim for students to develop metacognitive deep learning of water tension and how a water strider utilises water tension to survive, whilst also developing their scientific inquiry skills. These lessons utilise HITS strategies such as explicit instruction, whilst building upon and scaffolding learning, developing scientific investigative skills within experiments, building upon existing knowledge.



These lessons provide a framework in which to support further thinking and conversations on topics such as climate change and pollution through evidence-based discussions.

We chose to look at water striders, firstly because this has not been covered by Primary Connections or a Waterwatch project before, and secondly, because we believed that this subject would be engaging and exciting for students. When first planning lessons we performed a quick formative assessment with some children. Most of the students we spoke to had seen water striders before, and many of them already thought they knew how they move on top of the water ("They float and dance" Theo, 5) "They have to keep moving quickly, so they don't sink" (Oliver, 8). During planning we realised therefore that as surface water tension and water striders are interconnected, it would be necessary for us to teach students how surface tension works before moving onto the ways in which water striders utilise this.

- One last important note for teachers, it may be best to teach these lessons from mid spring to early Autumn, when water striders are most active. We planned these lessons at the beginning of winter, and although we did find some water striders (in southern NSW) they were not as plentiful and easy to find as they are during the Summer.

The main learning intention for these lessons…

I now understand how water striders utilise surface water tension to allow them to travel above the water.

The success of the learning intention will be assessed through the students creation of a poster and a model of a water strider, and assessed against a Rubric that covers the curriculum codes. (appendix 3).

Links to the Victorian Curriculum:

Curriculum focus; Grade 5

Under the Victorian Curriculum science content our lessons will cover the below codes;

SCIENCE UNDERSTANDING/BIOLOGICAL SCIENCE	SCIENCE AS A HUMAN ENDEAVOUR	SCIENCE INQUIRY SKILLS
Solids, liquids and gases behave in different ways and have observable properties that help to classify them(VCSSU076)	Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people's lives(VCSSU073)	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules(VCSIS082)
Living things have structural features and adaptations that help them to survive in their environment (VCSSU074)		Compare data with predictions and use as evidence in developing explanations (VCSIS086)
The growth and survival of living things are affected by the physical conditions of their environment (VCSSU075)		Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships(VCSIS088)

These lessons also include curriculum codes from the following areas;

Critical and Creative Thinking	**Ethical Capability**
Examine how different kinds of questions can be used to identify and clarify information, ideas and possibilities (VCCCTQ021)	Explore the significance of 'means versus ends' by considering two ways to act when presented with a problem: one that privileges means and one ends(VCECD012)

These lessons may also cover the below Cross Curriculum Priorities;

Aboriginal and Torres Strait Islander Histories and Cultures	**Sustainability**

OI.2 Aboriginal and Torres Strait Islander communities maintain a special connection to and responsibility for Country/Place	OI.3 Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.
Western scientists seek to understand structural features of living things in terms of functions, such as adaptation in the context of evolution. Indigenous people may have their own way to explaining the structural features of living creatures. When teaching these lessons teachers can contact local Indigenous community members and/or Indigenous Education Officers to access relevant, local Indigenous knowledge.	Students investigate water striders dependence upon water tension. Students can consider how the destruction or pollution of their environment could affect water striders.

UNIT AT A GLANCE

PHASE	**LESSON**	**Learning Outcomes/Aims of the stage**	**Main Activity**
..ENGAGE	**Lesson 1:** Water Surface water tension and considering water strider features	**Diagnostic and Formative Assessment** During this stage we elicit prior knowledge and provide provocations for further questions. We aim to engage and excite the students around the concepts of surface water tension and introduction to how a water strider floats.	**Video:** Exploring the visual aids and brainstorming their thoughts/questions on surface water tension and basic structure of water striders. **Activity:** Will it sink or float task with water in a bowl? Develop TWLH chart after both tasks for the rest of the unit.
EXPLORE	**Lesson 2:** Water Surface Tension	**Formative and Diagnostic Assessment** Provide students hands on experience with scientific trials/experiments and data collection. Provide students with hands-on shared experiences exploring the properties of water, and how surface tension differs and interacts between substances.	**Experiment 1:** Water drop on a coin **Experiment 2:** Water drop on a coin, with additional substances
EXPLAIN	**Lesson 3:** Water Surface Tension	**Formative and Diagnostic Assessment** Students attempt to Explain the knowledge gained about surface tension in the explore stage. Start to consider how water striders might use this to survive on the surface of water.	**Explicit teaching:** Properties of water and the impact of additional substances on Surface Tension **Student task:** Explain surface tension through words and pictures
ELABORATE	**Lesson 4:** Water Surface Tension ----------	**Summative assessment.** We aim for students to understand how and why surface tension works, and some factors that can affect it. Students are assessed against a rubric throughout the lesson. Support Students to explain and then represent the understanding of surface water tension. Introduce scientific views of water tension. ----------	**Experiment -** demonstrate water tension by floating a paperclip. Investigate water tension by changing variables. ----------

	Lesson 5: Water Strider Elaboration	Students research information about the structural features and adaptations of water striders to move across the surface of water. By the end of the lesson Students can identify features of water striders that enable them to use surface tension to move.	**Excursion -** Students will form groups to Investigate water striders in their habitat. **Classroom -** Students will observe water striders within a controlled environment.
EVALUATE	**Lesson 6:** Presentations	**Summative Assessment** Learners recap and apply their learning through creation of a water strider using wire and creating a poster displaying what they now understand about surface tension and water striders. By the end of the lesson Students have demonstrated their scientific knowledge of water striders and surface tension as well as their scientific inquiry skills.	**Main Activity** -Students will be making a poster on water striders and water surface tension. - Students will also make a strider out of wire.

Safety

For our students to safely and ethically use materials and equipment teachers must review each lesson before teaching in order to manage potential safety issues. We have provided a safety icon (above) for lessons where there is a need to pay attention to potential safety hazards. Please;

- Students or teachers report all accidents, injuries, and breakage of glass or equipment immediately.
- Make yourself aware of the schools safety policies
- Check student records for allergies or other health issues
- Keep pathways clear by placing extra items (books, bags, etc.) on the shelves or under the work tables. If under the tables, make sure that these items can not be stepped on.
- Ensure students wear closed footwear and secure loose clothing
- Make sure students are aware of the assigned experiment by by reading instructions before they start to work.
- Stress that unauthorized experiments or procedures must not be attempted.
- Students should leave work stations clean and in good order and clean up any spills immediately.
- Students should learn the location of the fire extinguisher and first aid kit.
- Follow all instructions given by your teacher.
- Learn how to transport all materials and equipment safely.
- There should be no eating or drinking during scientific experiments
- Display safe science practices in the classroom.

Lessons

Chapter 1: ENGAGE

TITLE: Walking On Water?

At a glance
Provide students with interactive experiences allowing students to: - Gain knowledge on an introduction to surface water tension, the film like layer that sits on top of the water and the idea of how water insects like the water striders can stay on top of the water without sinking. - Be engaged and enjoy learning the content - they will be encouraged to develop their own questions on how surface water tension works, and how things sink and float.

AIMS OF THE STAGE:

- Throughout the engage stage students eliciting their prior knowledge through positive, fun, stimulating learning experiences and drawing upon their interest in the content topic. The teacher can perform diagnostic assessments to determine the student's prior knowledge.

LEARNING OUTCOMES:

- Students will be scientifically making their own hypothesis on how a water strider stays above the water and walks on top of it.
- Students will discuss the idea of surface water tension and understand the properties of it.
- Students will understand what the 'layer' on top of the water is caused by and how it is developed.

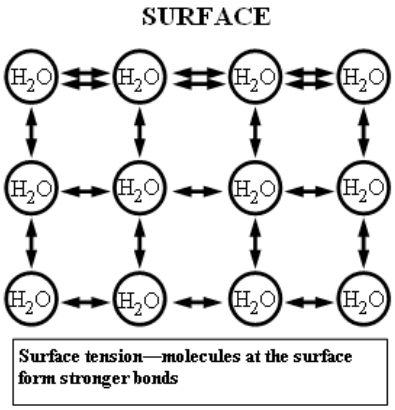
DIAGNOSTIC ASSESSMENT:

- The teacher can determine their prior knowledge on water tension via their expression of thoughts throughout questioning …

INFORMATION TO TEACHERS:

- *Surface water tension provides duties that are vitally important to the environment, and for the creatures that live within its surroundings.*
- *Defined: **Surface Tension:** "The property of the surface of a liquid that allows it to resist an external force, due to the cohesive nature of its molecules."*
- *It is the cohesive forces in between liquid molecules that is responsible for the phenomenon of 'surface water tension'.*
- *The top layer of the water is not a 'skin' on top of the water, it must be known that the stronger the cohesion bond between the liquid (water) molecules as opposed to the attraction of water molecules to air increases difficulty to move an object through the surface to the bottom of the water than to move it when it is completely submersed.*
- *Cohesion and Water Tension: The cohesive forces between the liquid molecules are shared within a community of neighboring molecules - on the surface there are no neighbouring molecules and therefore, these exhibit strong attractive forces on their closest neighbours on and below the surface area.*
- *Using an example of a paper clip - metal having a much higher density should sink to the bottom of a cup of water, but defying physics the high surface tension density helps the paper clip float.*
- *The example of a water strider walking on water**:** Small insects such as the water strider can walk on water because their weight is not enough to penetrate the surface.*
- *Water striders use this surface tension to their advantage through their highly adapted legs and distributed weight. The legs of a water strider are long and slender, allowing the weight of the water strider body to be distributed over a large surface area. The legs are strong, but have flexibility that allows the water striders to keep their weight evenly distributed and flow with the water movement. Hydrofuge hairs line the body surface of the water strider.*
- *TOP LAYER OF WATER: As there is a high water tension density there tends to be an upper layer of film like substance on top of the water that does not dissolve or sink. Due to the surface tension, small objects (Such as*

a water strider) will "float" on the surface of a fluid, as long as the object cannot break through and separate the top layer of water molecules. When an object is on the surface of the fluid, the surface under tension will behave like an elastic membrane.

- 

[The information above is at an academic level for teachers to develop the basic concept of water tension, liquid molecules and to introduce the idea of how a water strider or such creatures can float. The information is here for teachers to feel more confident in the content they will be covering with primary students - the vocabulary being used is at an advanced scientific level and should be altered to suit the age of the students.]

EQUIPMENT:

- 20-25 Small bowls
- Pond water from Newells paddock in Footscray (enough for each bowl)
- Toy water strider/bug (plastic) for each student (20-25)
- ICT tools to connect video to smartboard or projector

LESSON STEPS:

Activity 1: Youtube Video & Mindmap: 'This Is Why Water Striders Make Terrible Lifeguards | Deep Look'.

Through viewing this video students are developing ideas/the concept of the water striders physical characteristics and the idea of how the surface tension can impact objects or animals sinking or staying above the surface.

- Have Qs on board: What do they look like? What could be helping them stride along the top of the water structurally? Why won't they sink? Is there possibly something with the water allowing them to stay on top of the water?

(See Appendix 1 for link to video)

- Think, Pair, Share with a partner then as a whole class discussion - Create a Mind map to display their answers on the class whiteboard/SmartBoard.

Activity 2: Main Activity: Will it sink or float?

- Students are given small bowls of pond water from Newells paddock in Footscray to act as a small pond if possible - or simply a bowl of water from the class tap.
- Students have small plastic bug toys and objects such as paper clips and matches to float on top of the water.
- Students begin to develop questions in small groups such as the following in a TWLH Chart. some examples include:
    1. What did you see once putting the plastic toy and objects in the water? How do you think the plastic toy or object floats?
    2. What is the layer/ film like substance on top of the water?
    3. How is the water creating this layer?

Alignment with Victorian Curriculum:

• SCIENCE UNDERSTANDING	• SCIENCE INQUIRY SKILLS
Solids, liquids and gases behave in different ways and have observable properties that help to classify them(VCSSU076)	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules(VCSIS082)

Appendices:

Appendix A - Video for activity 1: This Is Why Water Striders Make Terrible Lifeguards | Deep Look.
https://www.youtube.com/embed/E2unnSK7WTE
Appendix B - How to use a TWLH chart

The TWLH chart is used to elicit students' prior Knowledge and determine which questions students want answered. The chart also documents what has been learned. The last sections asks students to justify the claims made in the first sections of the chart and reconsider the ideas in the first parts.

What we **think** we know	What we **want** to learn	What We **Learned**	**How** we know

Chapter 2 – Explore

Title - Sticky Water

At a glance
Provide students with interactive experiences allowing students to: - Retrieve/access any prior knowledge of water tension - Explore the ways in which other materials and substances impact water tension - Discuss and document new observations, ideas, and questions.

AIMS OF THE STAGE:
Following from the **engage** phase students will have a piqued interest in the unique properties of water and how it water interacts with its environment.

The **explore** stage will provide students opportunities to participate in scientific experiments and record observable data. Through this process, students will explore the concepts by making and recording estimations, discussing the reason for their estimations, perform trials and experiments, record data, and discuss results in specific and generalised terms. The shared experience of the explore activities provides students a shared experience that can be discussed and explained – and provides an opportunity for students to ask questions based on deeper understanding as they begin to observe real-life scientific occurrences.

FORMATIVE ASSESSMENT:

Throughout the explore stage, the assessment focus for the teacher is for **Formative Assessment.** Formative assessments will allow the teacher to monitor student's understanding of tasks and key concepts, and allow the teacher to provide targeted feedback to extend the student's learning.

Through the explore phase, teachers can use ICT to great effect by taking photos throughout the activities. The photos become an efficient formative assessment to track student understanding and engagement, as well as providing evidence for students to focus their discussions at the end of the lesson and throughout the rest of the unit.

In this lesson, formative assessments should document the students' developing science inquiry skills and understanding the properties of the surface tension of water.

LEARNING OUTCOMES:

Science	Literacy
- Follow directions to investigate… - Make a prediction, observe, record, and interpret the results of their investigation - Follow safety procedures - Identify the features of unbiased scientific testing	- Follow a procedural text to complete an investigation - Use oral, written and visual language to record and discuss investigation results - Engage in discussion to compare ideas and relate evidence from an investigation to explanations about water tension

INFORMATION TO TEACHERS:
'Surface tension' or 'water tension' is the term given to the occurrence of bonded molecules on the surface of water. These bonded molecules on the surface of water are observed as an elastic-like force that allows water to hold its form slightly beyond spillage point.

This property of liquids is a result of molecules of one substance being more attracted to molecules of the same substance rather than another substance. This can cause easily observed examples like water beading on a tabletop and a cup of water being filled slightly past the point of spillage while holding a curved/dome shape above the lip of the cup.

This property of liquids can be defined as **cohesion** or as the **intermolecular attraction between like molecules.**

It is important to remember that water is unique, in that it has a high surface tension compared to other liquids. This is a scientific fact that can be the start of a lot of fantastic exploration into other substances, how molecules interact, and how other substances impact the surface tension of water.

Water's unique surface tension:
Water is formed when two hydrogen atoms share an electron with on oxygen atom. This is a **covalent bond**. Because of the shape of the H2O molecule, the molecule has a moderate negative charge near the Oxygen atom, and a moderate positive charge near the Hydrogen atoms. The presence of the positive and negative charge at either end of the molecule is called polarity.

When two H2O molecules interact with each other, the positive charge (hydrogen) at one end of the molecule is attracted to the negative charge (oxygen) at the end of the other molecule. This is a **cohesion bond**. When multiple H2O molecules interact, this attraction is repeated over and over so that the H2O molecules stick together – creating water's high surface tension.

(NASA)
Key terms:

Hydrogen	First element on the periodic table and the most abundant element in the universe
Oxygen	Eighth element on the periodic table and third most abundant element in the universe
Atom	Single unit of an element
Molecule	Group of bonded atoms
Polarity	A molecule having a positive charge at one end and a negative charge at the other end
Covalent Bond	Atoms sharing an electron Eg: two hydrogen atoms sharing an electron with an oxygen atom
Cohesion Bond	Negative charged atom of one molecule attracting positive charged atom of another molecule

EQUIPMENT:

Teaching resources:

- Water tension experiment sheet
- Whiteboard/markers
- Device with camera (and airplay/HDMI capability)

Every student/pair/lab group will need:

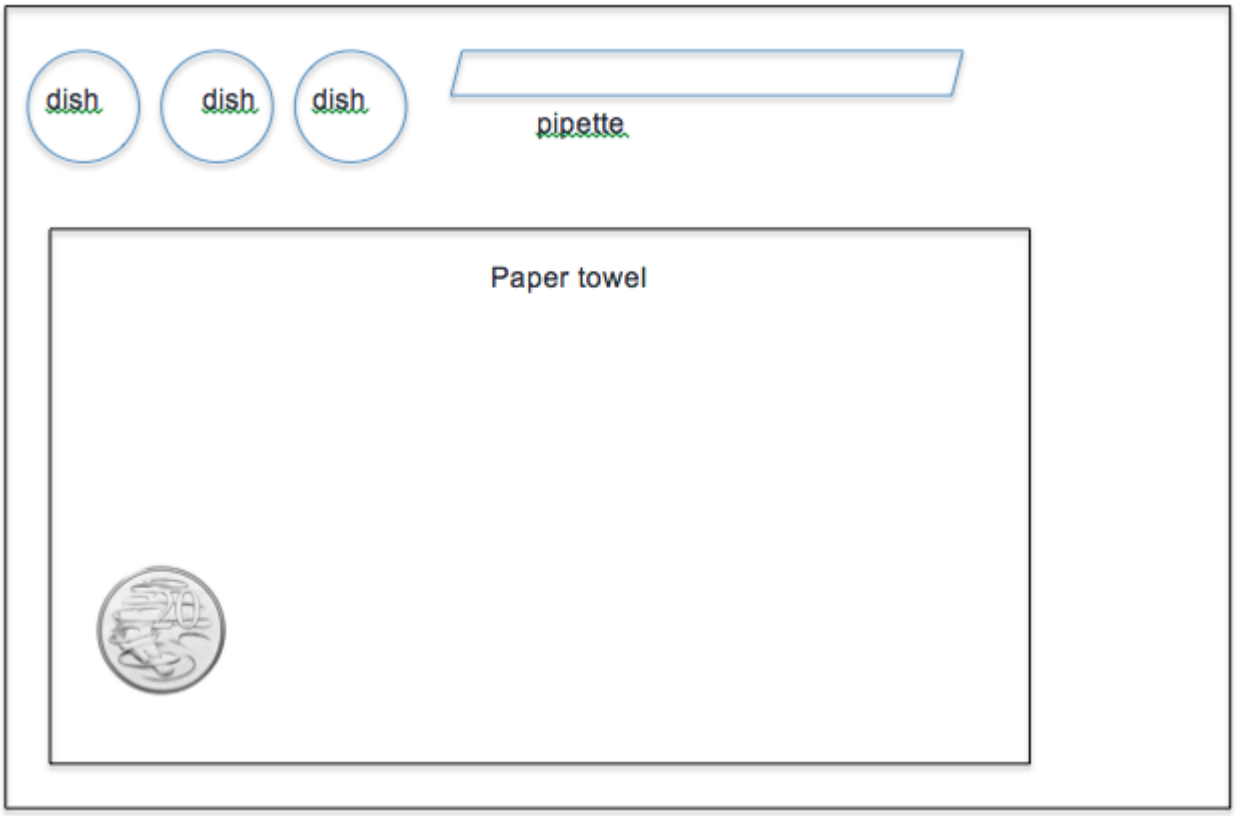
- 1 X 20 cent coin
- 1 X Pipette
- 4 X Small dish
- 1 X Paper towel

Class will need access to these materials to fill their small dishes:

- Alcohol (Methylated Spirits)
- Dish soap
- Water

Preparation:

- Set one workstation in advance. Workstation should be recreated by students;



- Access to water, alcohol, dish soap, and paper towel to be managed by teacher
- Have TWLH chart on display and accessible to students.

Lesson Steps:

1. Review discussion from previous lesson.
Review TWLH chart

2. Introduce the focus for today's lesson
- Today we will be working with a lab partner to complete an experiment
- We will be exploring how water interacts with its environment and with other substances

3. Read through class copy of the experiment sheet. This allows the teacher to clarify any points, as well as assess the students engagement and ability to complete tasks.
Discuss the purpose and features of a procedural text (link to literacy curriculum).
At this point, students can write down notes they want to add to the TWLH chart based on how they think the experiment might play out (write on post-it note to avoid large-scale interruptions of students moving around the classroom).
4. First allow students to play with coin, feel its dimension and discuss the first estimation. Share observations and estimations with each other and complete estimation section of sheet
5. Discuss what may be an impact of other substances being introduced to the water. What might be some changes, what might be some reasons? Note these separately (allowing students to offer suggestions without fear of failure, encourage divergent thinking/outside the box. Encourage students to offer suggestions without being married to that answer).
6. Instruct students to commence experiment. Provide a visual timer (either written on the board or via smart TV/video) encouraging the students to complete the tasks in the allocated times.
7. Facilitate discussion after **Experiment 1.**
Allow students to make notes (post-it notes) to put on their TWLH chart).

Discussion questions/focus:

- Estimations; Who made an estimation that was correct or very close?
  What were some of the reasons for your estimation?
  Do you think your reasons were accurate?
  Were there other factors?
  Who did not get close?
  What were your reasons? Were your reasons accurate or off?
- Results; Who can describe what they observed during the experiment?
  What happened, what did it look like?
  What scientific effects do you think were working in your experiment? Do you think there were big forces at work, like gravity? Do you think there were small forces at work, like atoms/cells/molecules?
  Do you think that all liquids will behave like water? (lead into estimations for experiment 2)

8. Students continue with **Experiment 2.**

9. Ensure students complete experiment with enough time to engage in discussion and pack space.

10. **Discussion questions/focus:**
- Estimations; Who made an estimation that was correct or very close?
- What were some of the reasons for your estimation?
- Do you think your reasons were accurate?
- Were there other factors?
- Who did not get close?
- What were your reasons? Were your reasons accurate or off?
- Results; Who can describe what they observed during the experiment?
- What happened, what did it look like?
- Why do you think some liquids behave differently to water?
- What scientific effects do you think were working in your experiment? Do you think there were big forces at work, like gravity? Do you think there were small forces at work, like atoms/cells/molecules?
- What connections can we make between this experiment and situations in the real world? How might other substances impact water/the environment/how water creatures live?

11. Update TWLH chart with new ideas/learning/questions/goals for the unit.

Alignment with Victorian Curriculum:

• SCIENCE UNDERSTANDING	• SCIENCE INQUIRY SKILLS
Chemical Sciences Solids, liquids and gases behave in different ways and have observable properties that help to classify them(VCSSU076)	**Questioning and predicting** With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules(VCSIS082)
	Planning and conducting With guidance, plan appropriate investigation types to answer questions or solve problems and use equipment, technologies and materials safely, identifying potential risks (VCSIS083) Decide which variables should be changed, measured and controlled in fair tests and accurately observe, measure and record data (VCSIS084)
	Recording and processing Construct and use a range of representations, including tables and graphs, to record, represent and describe observations, patterns or relationships in data (VCSIS085)

Appendices:

Appendix C – Resource Sheet 1;

Experiment's instruction and record sheet:

How many drops will my coin hold?

Experiment 1	
	Set workstation to example provided.
	Discuss and record your estimation for how many drops of water will hold on the top of the coin using record sheet
	Using pipette, one group member slowly adds one drop of water to the face of the coin.
	While one partner is dropping water onto the coin, another group member is recording the exact amount of water drops held on the face of the coin.
	Continue adding water drops till the water tips over the edge of the coin.
	Document observations in record sheet.
	Clean/dry coins and workstation, and repeat experiment until record sheet has been completed.

Experiment 2	
	Mix your additional substances to water in the dishes provided
	Document your estimations on the record sheet
	Using pipette, one group member slowly adds one drop of solution to the face of the coin.
	While one partner is dropping solution onto the coin, another group member is recording the exact amount of water drops held on the face of the coin.
	Continue adding water drops till the water tips over the edge of the coin.
	Document observations in record sheet.
	Clean/dry coins and workstation, and repeat experiment until record sheet has been completed.
	Clean/dry coins and workstation and repeat experiment steps with other solutions.

My estimation – Water Drop	
How many drops?	What will it look like?
What is the reason for my answers?	
Test 1	
Who many drops?	What does it look like?
How has my thinking changed?	
Test 2	
Who many drops?	What does it look like?
Test 3	
Who many drops?	What does it look like?

My estimation – Solution with alcohol	
How many drops?	What will it look like?
What is the reason for my answers?	
Test 1	
Who many drops?	What does it look like?
How has my thinking changed?	
Test 2	
Who many drops?	What does it look like?
Test 3	
Who many drops?	What does it look like?

My estimation – Solution with soap	
How many drops?	What will it look like?
What is the reason for my answers?	
Test 1	
Who many drops?	What does it look like?
How has my thinking changed?	
Test 2	
Who many drops?	What does it look like?
Test 3	
Who many drops?	What does it look like?

Chapter 3: Explain

Title - Connecting The Dots

At a glance
Provide students with structured discussions enabling students to: - Retrieve/access any prior knowledge of water tension - Use prior knowledge, results from experiments, and teacher-provided resources/information to synthesize new understandings of the properties of water - Document understanding of the unique properties of water.

AIMS OF THE STAGE:

During the explain stage students consider what their results mean, and give the data collected in the explore stage meaning. Students develop a product that represents their understandings and identify the relationships in their observations during the explore stage. This is the first time that teachers introduce new terms, constructing concepts.

Following from the explain stage, students will be provided the opportunity to revise their estimations/hypotheses and the results of their experiments. Following review, students will be provided explicit instruction of the key terms and concepts and be provided further opportunities to review and revise their synthesized understand of the properties of water.

Following the explicit instruction of the properties of water, specifically surface tension, students will collate all their data to formulate their own understanding of water tension and draft their first visual description of the unique properties of water. Without mandating it's inclusion in their produced work, discussion should be guided to include how the Water Strider may use surface tension to its advantage, and other occurrences of creatures utilising this naturally occurring phenomenon.

LEARNING OUTCOME:

Science	Literacy
- Use oral, written and visual language to demonstrate an understanding of scientific concepts/phenomena - Identify the features of unbiased scientific testing - Interpret scientific data in new and easily understood ways	- Use oral, written and visual language to record and discuss investigation results - Engage in discussion to compare ideas and relate evidence from an investigation to explanations about water tension

FORMATIVE ASSESSMENT:

Throughout the explain stage, the assessment focus for the teacher is Formative Assessment. Formative assessments will allow the teacher to monitor student's understanding of previous tasks completed throughout the explore stage and their broader understanding of the properties of water. The formative assessment should also allow the teacher to provide targeted feedback to extend the student's learning.

Through the explain stage, the teacher will be providing new information that draws on the observations made during the explore stage. By utilising the prior knowledge and providing clear definitions to explain the concepts, formative assessments are important to ensure the class has achieved their learning outcome and can move onto the next stage of the unit. If the formative assessment shows examples of students unable to understand and interpret the key concepts, amendments to the delivery of the unit and it's timeframe for delivery should be revisited to suit students learning needs.

Formative assessment will made through informal methods such as photos of work and note taking during class discussion. Assessment will also be made through more formal methods such as the piece of work created by students to demonstrate their understanding of surface tension.

Use Rubric to assess students science inquiry skills (appendix 2**)**

INFORMATION TO TEACHERS:

(See Teacher background information: Lesson 2)

Surface tension or water tension is the term given to the occurrence of bonded molecules on the surface of water.
These bonded molecules on the surface of water are observed as an elastic-like force that allows water to hold its form slightly beyond spillage point.
This property of liquids is a result of molecules of one substance being more attracted to molecules of the same substance rather than another substance. This can cause easily observed examples like water beadin**g** on a tabletop and a cup of water being filled slightly past the point of spillage while holding a curved/dome shape above the lip of the cup.
This property of liquids can be defined as cohesion or as the intermolecular attraction between like molecules.
It is important to remember that water is unique, in that it has a high surface tension compared to other liquids. This is a scientific fact that can be the start of a lot of fantastic exploration into other substances, how molecules interact, and how other substances impact the surface tension of water.

Water's unique surface tension:
Water is formed when two hydrogen atoms share an electron with on oxygen atom. This is a covalent bond. Because of the shape of the H2O molecule, the molecule has a moderate negative charge near the Oxygen atom, and a moderate positive charge near the Hydrogen atoms. The presence of the positive and negative charge at either end of the molecule is called polarity.
When two H2O molecules interact with each other, the positive charge (hydrogen) at one end of the molecule is attracted to the negative charge (oxygen) at the end of the other molecule. This is a cohesion bond. When multiple H2O molecules interact, this attraction is repeated over and over so that the H2O molecules stick together – creating water's high surface tension.

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Covalent Bond	Atoms sharing an electron Eg: two hydrogen atoms sharing an electron with an oxygen atom
Cohesion Bond	Negative charged atom of one molecule attracting positive charged atom of another molecule

EQUIPMENT:

Teaching resources:

Screen (smart TV/AppleTV/Smart whiteboard)
Photos/videos from previous lesson
Water tension video
Student work resources (paper, pencils, textas, pens)
TWLH chart

LESSON STEPS:

1. Using round Robin Charts a group of four or five students have a chart and markers. Each group answers the following questions…
   How do we think water tension works?
   What do we think might affect water tension?
2. Students share knowledge they have gained about water tension so far. They then pass the chart onto the next group. Once all groups have filled out the chart the results are discussed in class.
3. Students begin to fill out the TWLH chart - What we think we know, what we want to learn.
4. Watch video: https://www.youtube.com/watch?v=A8n678m6ZgI explaining surface tension.
   What connections can you make between our experiment and the one in the clip?
   What reason/explanation do they give for surface tension?
   How can we explain surface tension using our own words pictures?
   Understanding student needs, use **explicit teaching** to describe the properties of water and how surface tension is achieved through molecule attraction.
5. Another clip: https://www.youtube.com/watch?v=9jB7rOC5kG8 explores surface tension in space
   What connections can be made? What is the same? What is different?
   Does this change your understanding? Help understanding?
6. Student activity (formative assessment)
   Draw and explain surface tension with as much detail how water molecules create surface tension. These will be displayed for future use.
7. Final clip: https://www.youtube.com/watch?v=5NCOnr3VSAY links surface tension to nature via Water Striders
   Can be played before or after activity, or as a teaser/taster for next lesson and elaboration stage.

Alignment with Victorian Curriculum;

• SCIENCE UNDERSTANDING	• SCIENCE INQUIRY SKILLS
Chemical Sciences Solids, liquids and gases behave in different ways and have observable properties that help to classify them(VCSSU076)	**Questioning and predicting** With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules (VCSIS082)
	Communicating Communicate ideas and processes using evidence to develop explanations of events and phenomena and to

	identify simple cause-and-effect relationships (VCSIS088)
	Planning and conducting With guidance, plan appropriate investigation types to answer questions or solve problems and use equipment, technologies and materials safely, identifying potential risks (VCSIS083)

Appendices:

Appendix D – Assessment Rubric: Adapted from:**https://www.primaryconnections.org.au/system/files/digital/Yr5_WTM_Rubrics.pdf**

Appendix E – Resource Sheet 2; TWLH Chart resource sheet (See Appendix B):

What we **think** we know	What we **want** to learn	What We Learned	**How** we know

Chapter 4: EXPLORE-EXPLAIN combined

Title: Floating Metal

At a glance
Provide students with interactive experiences allowing students to: - Expand upon knowledge of water tension - Explore the ways in which other materials and substances impact water tension - Discuss and document new observations, ideas, and questions.

AIMS OF THE STAGE:

In the Explore-Explain phase students plan and conduct an open investigation to apply and extend their new conceptual understanding in a new context. This stage is designed to challenge and extend students' science understanding and science inquiry skills.

LEARNING OUTCOMES:

Students will be able to:

Science

- formulate a question for investigation to gather evidence about surface tension
- plan and conduct a fair test to test their ideas
- make and record observations
- provide evidence to support their conclusions.

Literacy

- represent results to interpret them and compare them to their predictions
- summarise their findings and relate them to the context of surface water tension
- engage in discussion to compare ideas and provide relevant arguments to support their conclusions.

SUMMATIVE ASSESSMENT:
Use the Rubric (appendix 2) to check and monitor students understanding of the Science Inquiry Skills.

Encourage Students to investigate their findings - students may check their water at home after discovering how to test water at school. Students may examine other research to compare with their own

INFORMATION TO TEACHERS:
Please watch the below video for a comprehensive explanation of water tension
https://www.khanacademy.org/science/biology/water-acids-and-bases/cohesion-and-adhesion/v/surface-tension

Water molecules are attracted to each other, and are pulling toward each other, but the molecules on the surface of the water don't have anything pulling from above, and so they are able to get closer to each other, creating surface tension.

As the temperature of a liquid increases, its surface tension decreases. As the water becomes warmer, its molecules become "excited" and increase their movement. This movement disrupts the imbalanced forces on the surface of the water and weakens the sheet-like barrier of tightly bound molecules, thereby lowering the surface tension.

(https://sciencing.com/changing-temperature-affect-viscosity-surface-tension-liquid-16797.html)

This is why hot water is more effective when cleaning clothes; its low surface tension allows it to more easily penetrate the fibers of a material like fabric and wash away stains.

EQUIPMENT:
TWLH Chart
Science Journals

For Experiment:
Water
Thermometer
Ice
Kettle
Bowls
Paperclips
Tissue Paper
Scales

Investigation Recording Sheet
Resource Sheet 3

LESSON STEPS:
Before beginning the lesson recap the previous lesson to put this new lesson in context.

In the first set of Explore-Explain students learn about the shape of the water surface and the effect of soap on surface tension. They will make observations and come to the following conclusions:

- The surface of the water forms a layer that is held together and separates the water from the surrounding air. It is called: Surface tension.
- The water surface tension tends to have a roundish shape.
- Water has a stronger surface tension than other substances. When detergent is added the surface tension decreases.
- Students will have developed explanations about the causes of surface tension:
  - ·Surface water tension is caused by the attraction of water particles at the surface to each other. They form a tight surface layer

- This attraction between particles of the same material (water in our experiment) is called *cohesion*
- Water particles underneath the surface seem less attracted to each other and are more loosely connected.
- When food colour is added, it stays on top of the layer of the water. The food colour and the water adhere to each other, but do not mix. This type of attraction is called *adhesion*.
- The force of cohesion, the attraction between water particles, is greater than the force of adhesion, the attraction between water and other substances.
- When detergent is added the cohesion forces break down, the food colour can now penetrate and spread within the water particles (or milk in the video).

1. Students and teachers will review the previous lessons using their science journals as well as the TWLH chart (See Appendix 2). Students are to recall what they learned about water surface tension. Assist students by summarising the recap information above. Ask Students, how do we have confidence in a claim? How can we confidently test that claim?

2. Ask students to review the W column in their charts. Ask: Are you more able now to answer some of the questions you had at the beginning of the unit? Are there questions that were not answered?

3. Are there any new questions that you would like to add? Ask students to add the new questions to the W column.

4. Tell students that today we will continue to examine characteristics of water tension.

We will conduct investigations that will enable us to answer the following questions:

a. How strong is the water tension?
b. How does temperature affect water tension?

Investigation 1

5. Write the first question on the white board: How strong is the water tension?

6. Ask students to suggest ways to investigate this question.

7. Students will discuss the appropriateness of the various suggestions. For example: putting their fingers into the water is not a good way to measure strength. However, if we gradually add weight, we could test how much weight is required to break the surface tension.
8. Tell the students that we will use paper clips to investigate the strength. We will test how many paper clips can a volume of water hold.

9. The teacher explains the following procedure for placing paper clips on the water:

a. We will begin by weighing a paper clip using kitchen scale. Students will record the weight in their journals
b. Each group of four students will fill a bowl with water three quarters high.
c. Tear a piece of tissue paper about half the size of a dollar bill
d. Gently drop the tissue flat onto the surface of the water
e. Gently place a dry paper clip flat onto the tissue (try not to touch the water or the tissue).
f. Record what happens
g. Repeat this procedure until the paper clips rupture the surface water and sink in.

10. Before students begin their investigation, ask students: How many paper clips do you think the water can hold?

11. What are the reasons for your predictions? What scientific knowledge that you learned so far helps you make these predictions? Use Appendix 4 - Science Question Starters for those students that need extra prompts
12 In your Investigation Recording sheet, fill in the following sections:

h. The investigation question
i. My predicted answer. Write in the form of:
The water can hold ____ paper clips. Each paper clip weighs ____ mg. Therefore I predict that the total weight that the water can carry is _____mg.
j. The reason for my prediction
k. Materials
l. Procedure – describe how you will test your prediction

13. Begin the investigation. Make sure to record the results in the Investigation Recording sheet.

14. Once students completed their investigation, ask student-groups to calculate the total weight of the paper clips held by the water. Ask students to come to the white board and record the results. Discuss the reasons for any differences.

15. Ask students how the results compare to their predictions.

16. Students complete the Investigation Recording sheet.

17. Students add their findings to the L and H columns in the TWLH charts.

(Above; Students of various ages (5-14) complete investigation 1)

The teacher may stop here or continue to the second investigation.

Investigation 2
18. Write the second question on the white board: How does temperature affect water tension?

19. Ask students to suggest ways to investigate this question.

20. Students will plan an investigation and discuss the appropriateness of the various suggestions.

21. Tell the students that we will use paper clips once again to investigate the strength of the water tension, in cold water and warm water. We will test how many paper clips can a volume of cold water hold, and a volume of hot water.

22. The teacher explains that we will repeat the same procedure as before, with the following changes:

Measuring water tension of cold water

Each group of four students will fill a bowl with tap water three quarters high. The bowl will be placed in a tub full of ice. The students will use a thermometer to record the temperature of the water. Once the water temperature drops to 10 degrees Celsius, they may start the experiment, following the steps of the previous investigation. Students should make sure that the temperature stays the same throughout the experiment, by adding or removing ice from the tub.

Measuring water tension of warm water

Students will place on the table an empty bowl in an empty tub. The teacher will boil water in a kettle. The teacher will fill the bowl of each group of students with boiled water, three quarters high. Students should be cautioned that boiled water have been heated in a kettle to 100 degrees Celsius, and that they should not touch the water. The students will use a thermometer to record the temperature of the water. Once the water temperature drops to 50 degrees Celsius, they may start the experiment, following the steps of the previous investigation. Students should make sure that the temperature stays the same throughout the experiment, by adding boiled water to the tub, whenever the temperature of the water in the bowl drops.

23. Before students begin their investigation, ask students: How many paper clips do you think the cold water can hold? How many paper clips can the hot water hold?

24. What are the reasons for your predictions? What scientific knowledge that you learned so far helps you make these predictions?

25. In your Investigation Recording sheet, fill in the following sections:

a. The investigation questions
b. My predicted answer. Write answer in the form of:

Water at 10 degrees Celsius can hold ____ paper clips. Each paper clip weighs ____ mg. Therefore I predict that the total weight that the cold water can carry is _____mg.

Water at 50 degrees Celsius can hold ____ paper clips. Each paper clip weighs ____ mg. Therefore I predict that the total weight that the hot water can carry is _____mg.

c. The reason for my predictions
d. Materials
e. Procedure – describe how you will test your predictions

26. Begin the investigation. Make sure to record the results in the Investigation Recording sheet.

27. Once students completed their investigation, ask student-groups to calculate the total weight of the paper clips held by the cold water, and the total weight held by the hot water. Ask students to come to the white board and record the results. Discuss the reasons for any differences.

28. Students complete the Investigation Recording sheet.

29. Ask students how the results compare to their predictions.

30. Ask students why they think the water tension of cold water is stronger than the water tension of hot water.

31. Summarise students' ideas and explain that when we raise the temperature of the water, the particles have more energy and they move around more, making the cohesive forces weaker. When the temperature is low, the particles have less energy. They move less, making the cohesive forces stronger

32. Students add their findings to the L and H columns in the TWLH charts.

Alignment With Victorian Curriculum

Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people's lives(VCSSU073)

SCIENCE UNDERSTANDING	SCIENCE INQUIRY SKILLS	SCIENCE UNDERSTANDING/SCIENCE AS A HUMAN ENDEAVOUR
Chemical Sciences Solids, liquids and gases behave in different ways and have observable properties that help to classify them(VCSSU076)	**Questioning and predicting** With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules (VCSIS082)	Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people's lives(VCSSU073)
	Communicating Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships(VCSIS088)	

Appendices: Differentiation – Enablers;
Appendix F – Science question starters

Science question starters

Question type	Question starter
Asking for evidence	I have a question about _____. How does your evidence support your claim? What other evidence do you have to support your claim?
Agreeing	I agree with _____ because _____.
Disagreeing	I disagree with _____ because _____. One difference between my idea and yours is _____.
Questioning further	I wonder what would happen if _____? I have a question about _____. I wonder why _____? What caused _____? How would it be different if _____? What do you think will happen if _____?
Clarifying	I'm not sure what you meant there. Could you explain your thinking to me again?

Appendix G – Resource Sheet 3; Science Investigation Record Sheet:

Science Investigation Record Sheet

Investigation 1: How strong is surface water tension?

Hypothesis Each paper clip weighs _____mg. I predict the water can hold _____paperclips, therefore I predict that the total weight that the water can carry is _____mg.
I think this because….
Materials needed
Procedure
Recording The water was able to hold_____paperclips, therefore the total weight the water could hold was _____mg

Investigation 2: How does temperature affect water tension?

Cold Water

Hypothesis Each paper clip weighs _____mg. I predict the 10 degrees Celsius water can hold _____paperclips, therefore I predict that the total weight that the 10 degrees Celsius water can carry is _____mg.
I think this because….
Materials needed
Procedure
Recording The cold water was able to hold_____paperclips, therefore the total weight the 10 degrees Celsius water could hold was _____mg
Reasoning: Provide scientific explanations for your results.

Hot Water

Hypothesis Each paper clip weighs _____mg. I predict the 50 degrees Celsius water can hold _____paperclips, therefore I predict that the total weight that the cold water can carry is _____mg.
I think this because….
Materials needed
Procedure
Recording The cold water was able to hold_____paperclips, therefore the total weight the 50 degrees Celsius water could hold was _____mg
Reasoning: Provide scientific explanations for your results.

Chapter 5: Elaborate

Title - Striding To Success

At a glance
Observing Water Striders; Students to view water striders in their environment and within a controlled space. Student will investigate about water striders' relationship with surface water tension and other surrounding features. Students: work collaboratively to observe, discuss and record throughout the investigation. Students will compare data from two different sources and will create inferences.

AIMS OF THE STAGE:

In the Elaborate stage, students will apply reasoning with their results by initiating further investigation and providing supporting evidence to consolidate their viewpoint.
Students will draw on the information collected in the previous lessons and provide explanations about their findings with strong evidence and research. Furthermore, students will construct ideas about water striders' features and present an understanding that shows the relationship between the subject and surface water tension.

LEARNING OUTCOMES:

Science
Students will be able to:

- Create an understanding about water striders and its relationship with surface water tension.
- Through guidance, develop inquisitive interest that segue towards effective investigation. Record and collect data about water striders when it is moving on a water surface.
- with support, create a planned investigation that embodies logical and controlled testing.
- Reflect and articulate on any results that are established.

Literacy
Students will be able to:

- Collaborate and contribute within discussions.
- Articulate and structure their results through diagrams and text.

SUMMATIVE ASSESSMENT:

Summative assessment of the Science Inquiry Skills is a important focus of the Elaborate phase. This will entail key resource sheets that will support students to research information about the structural features and adaptations of water striders to move across the surface of water. Upon completion, students' submissions will be based on the rubric provided (Appendix 2).

INFORMATION TO TEACHERS:

a. Animals that walk on water and water striders. See https://www.livescience.com/32639-how-do-animals-walk-on-water.html https://blog.nationalgeographic.org/2014/06/19/amazing-animals-that-walk-on-water/
b. Good sites and seasons to spot water striders
c. Excursion preparation & safety procedures (see the Department of Education site for information about excursions). Suggest teachers to do a preparatory excursion to familiarize themselves with the site.
d. Elaborate stage is reccomended to be completed either in an one half day activity or divide it into

three sessions of 45 to 90 minutes each.

EQUIPMENT:

-extended telescopic bug catcher nets (1 per 4 students)
-camera
-magnifiers
-small water containers
-Resource book: Gooderham, J and Tsyrlin, E. (2009).The Waterbug Book: A guide to Freshwater Macroinvertebrates of Temperate Australia. CSIRO: Publishing: Victoria: Australia, pp.112-113,145-147, 158-161.

LESSON STEPS:

In Class – preparation for an excursion:

1. Explain to students that we are going to observe small animals that walk on water in their natural habitat.
2. As a whole class, ask students if they have seen animals walking on water before. If so, ask questions such as:
Where have you seen them?
What do they look like?
What have you seen them doing?

3. During the discussion, if students say that they have seen animals walking on water, then ask the following:
How do you think they are able to do that?
Do you think that this might have any connection with the water tension?

4. Prepare students prior to the excursion at the pond:
a. Ask students to get into groups of four.
b. Give each group the Excursion Observation Protocol. Ask students to read the instructions; assess their understanding of the activity; and show how to fill out the sheet.

Provide students with an excursion form outlining:
- Clothing instructions.
- the time and location of the excursion.
- detailed safety instructions, such as, being clear that students should not go into the water, etc…

Excursion:

1. Students get into their pre-assigned groups of four (see Excursion Observation Protocol).

2. Students will be instructed to observe and identify different animals, whilst the teacher facilitates the groups with their observations.

3. Encourage students to catch water striders. If not available, other water animals with similar features.

4. During observations, ask student to have a closer look at the legs with the magnifiers.

5. Ensure at the end of the activity, students return their animals safely back into the pond.

In Class – Excursion Summary:

1. Ask the students to share their observations from the pond excursion.

2. Ask students:
- What features of the water striders did you observe?

- How might this help to explain how these animals walk on water?

3. Ask students to examine their TWLH charts and discuss what they have discovered regarding their surface tension knowledge.

4. Provide students with the images of the water striders' legs (see Appendix K) to further develop their explanations.

5. Prompt the following question: How do water striders walk on water? Students will use the Observation Protocol, TWLH chart, and images in Appendix K to develop their explanations.

6. Student groups will present their explanations to the class.

7. Present the following video to students explaining how water striders walk on water:
https://www.youtube.com/embed/E2unnSK7WTE

8. Revisit the question provided to the students: How do water striders walk on water?
Summarise the answer with the following explanations –

Water striders are able to walk on top of water due to a combination of several factors, including:

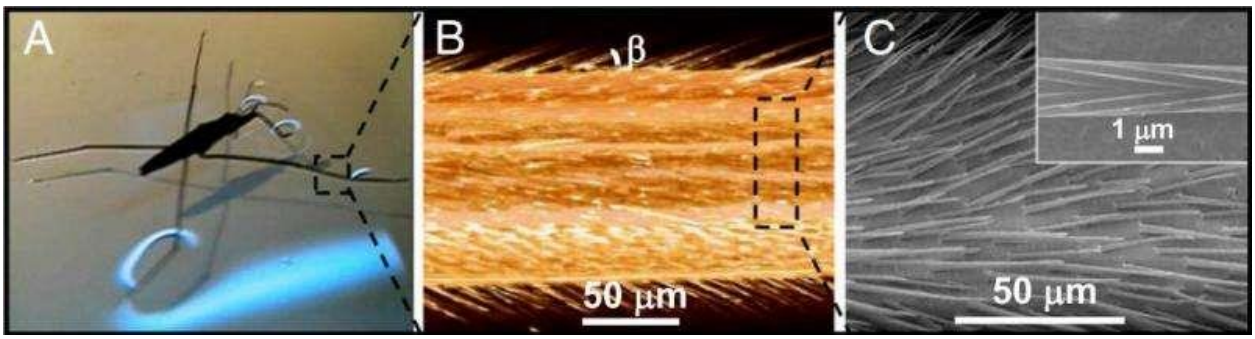
a. The high surface tension of water.

b. They have long and slender legs that help them stay above water. The long legs help them distribute their weight over a large surface area of the water. This means that the force on the water tension at any point, is relatively smaller with the long legs, compared to short legs.

c. The body and legs of the strider are covered with tiny oily hair that repels water. There are several thousand hairs per square millimeter, providing the water strider with a water repellent body that prevents wetting from waves, rain, or spray. Without these hair, the water droplets would get stuck on the body (through adhesion), add to the weight of the body, and eventually the weight would cause the surface tension to break.

d. The hair also works as a 'float vest'. Little bubbles of air get trapped between the hair in the same way that float vests get filled with air. These air bubbles help the striders float.

e. The strider moves by creating a semicircular wave that pushes the strider forward (Wikipedia https://en.wikipedia.org/wiki/Gerridae)



9. Ask students to add the new information they learned to the L and H in their TWLH charts.

Fun facts:
One of the features of a water strider that enables it to walk on water are its long legs. For a human to walk on water using surface tension, our legs would have to be at least 1 kilometer long!

Water striders often move at 1 meter per second, or 60 meters per minute.

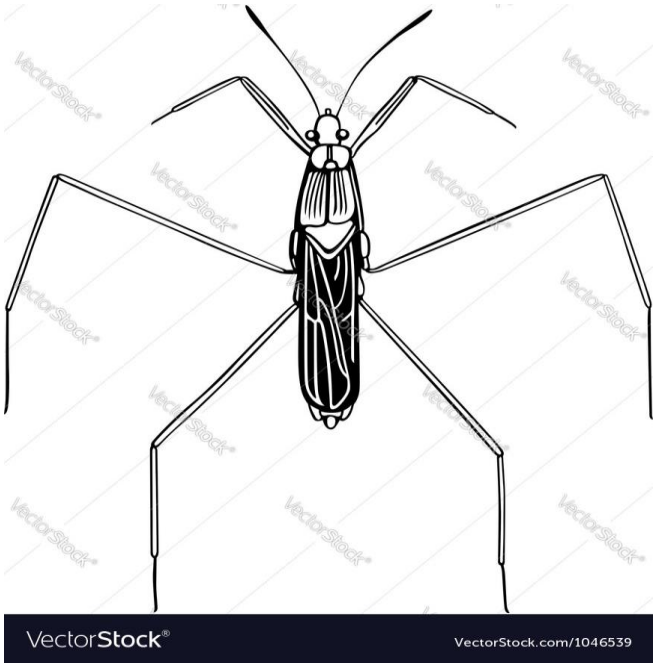
Alignment with Victorian Curriculum:

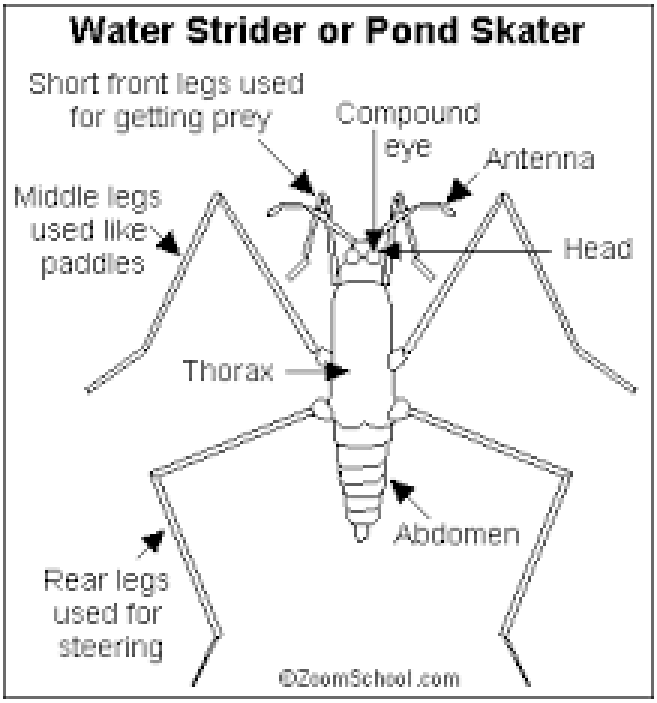
● SCIENCE UNDERSTANDING	● SCIENCE INQUIRY SKILLS
Biological Sciences (VCSSU074) Living things have structural features and adaptations that help them to survive in their environment.	**Recording and processing:** (VCSIS085) Construct and use a range of representations, including tables and graphs, to record, represent and describe observations, patterns or relationships in data.
	Communicating Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships(VCSIS088)

Cross Disciplinary content;
Ethical Capability; Decision Making and Actions

(VCECD012) Explore the significance of 'means versus ends' by considering two ways to act when presented with a problem: one that privileges means and one ends.

Appendix H – Features of a Water Strider:





Appendix I – Resource Sheet 4; Excursion Observation Protocol (page 1):

OBSERVATION PROTOCOL

Group members' names_____
Date_____
Location_____

Instructions:
1. Look at the surface of the water. Can you see any animals on the surface of the water?

_____
_____

2. Once you have found a water animal, use the telescopic net to scoop it out of the water.

_____
_____

3. When the animal is still in the net, ask your teacher whether the animal is a spider or an insect. If it is a spider, release it back to the water, careful not to touch it. If it is an insect, continue to watch what it does.

_____
_____

4. Without touching the animal, put it into a sealed container that is half filled with pond water. Handle the animal with great care and avoid any harm.

_____
_____

5. Find out what type of insect is in the container by using The Waterbug Book. Record what you have found using the Observation Protocol sheet.

_____
_____

6. Use the magnifier to look closely at the insect in the container. Make a drawing of the insect and label the body parts.

_____
_____

7. Describe the insect's behaviour (How does it move? What is it doing?)

_____
_____

8. Release the insect back into the water.

_____
_____

9. Collect another insect and repeat instructions.

_____
_____

(Table 1. Observation recording on other side of page)

Appendix J – Resource Sheet 4; Excursion Observation Protocol (page 2):

&
&
Table&1.&Observations&&ecording&
&

Insect 1	Insect 2
Identification	Identification
Labelled drawing	Labelled drawing
Description of behaviour	Description of behaviour
! ! . ‼ ! ! ! ! ! . ‼ ! ! ! ! ! ! ! . !	! ! . ! ! ! ! ! ! . ‼ ! ! ! ! ! ! ! . ! ! !

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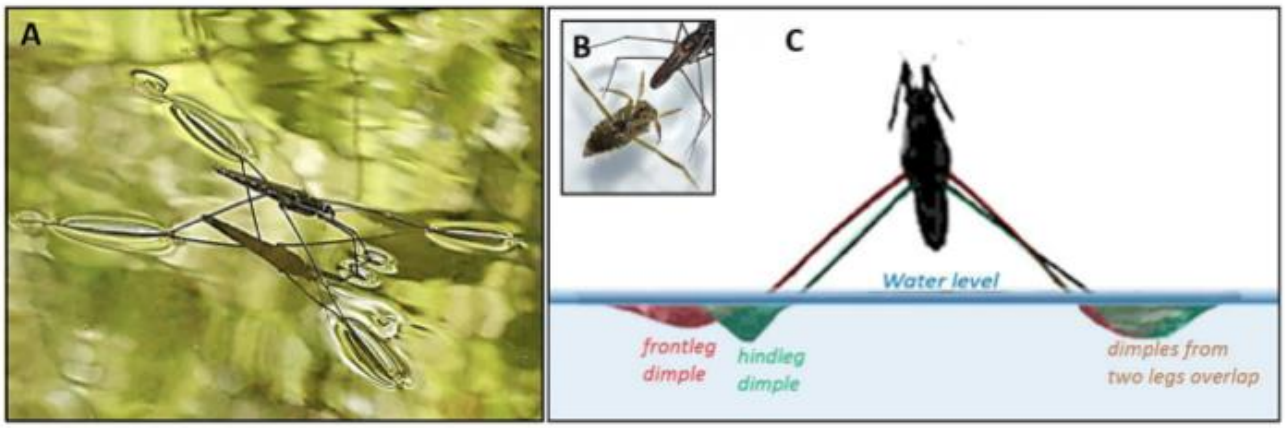
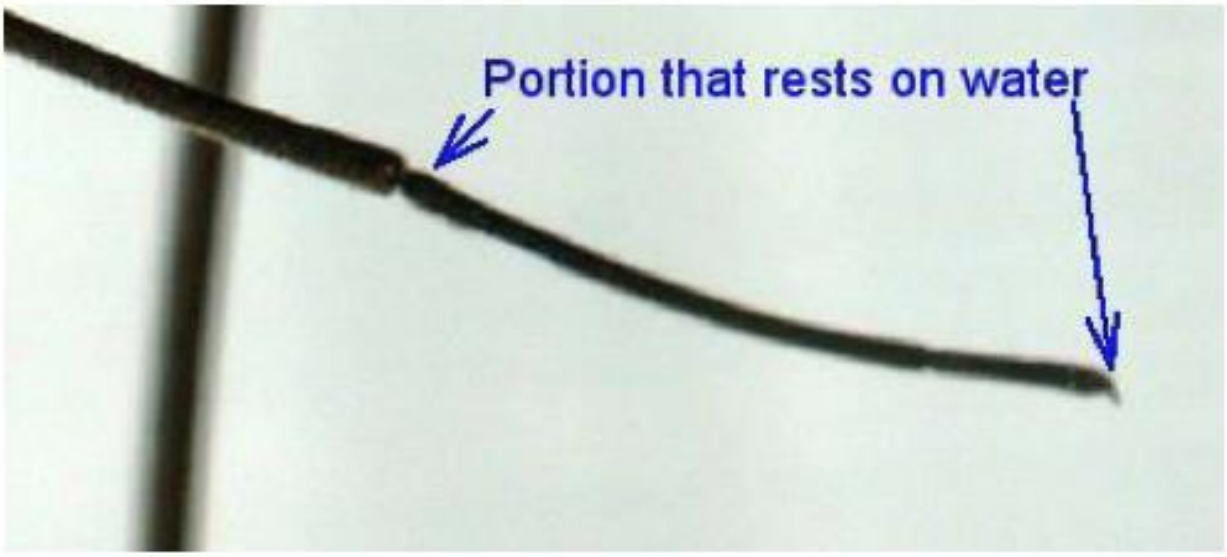
Appendix K – Images of water striders and water surfaces:

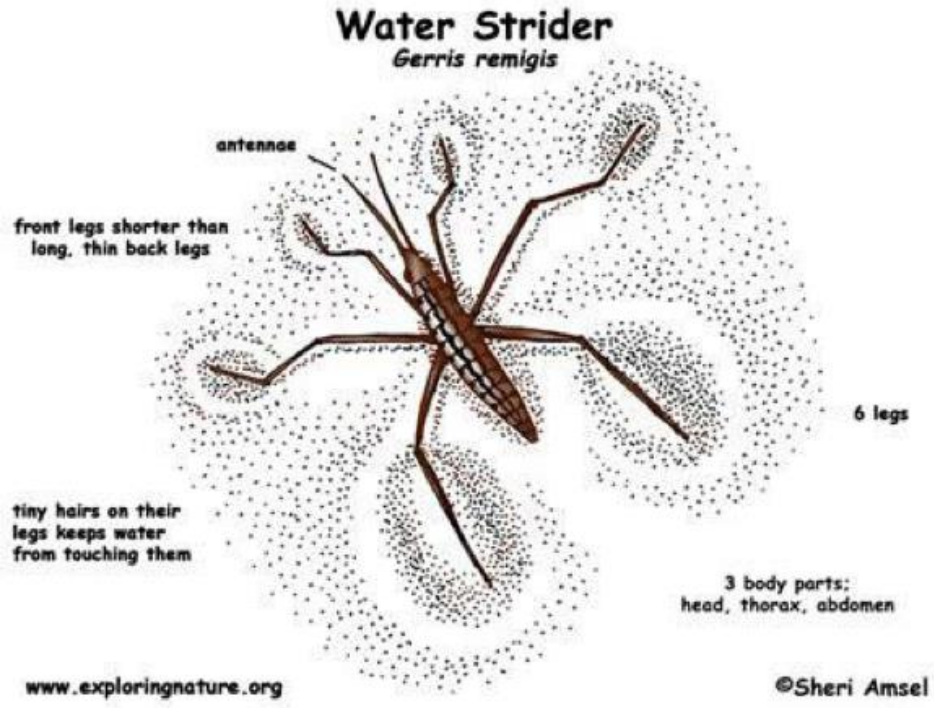
Picture 1. Water strider movement on water



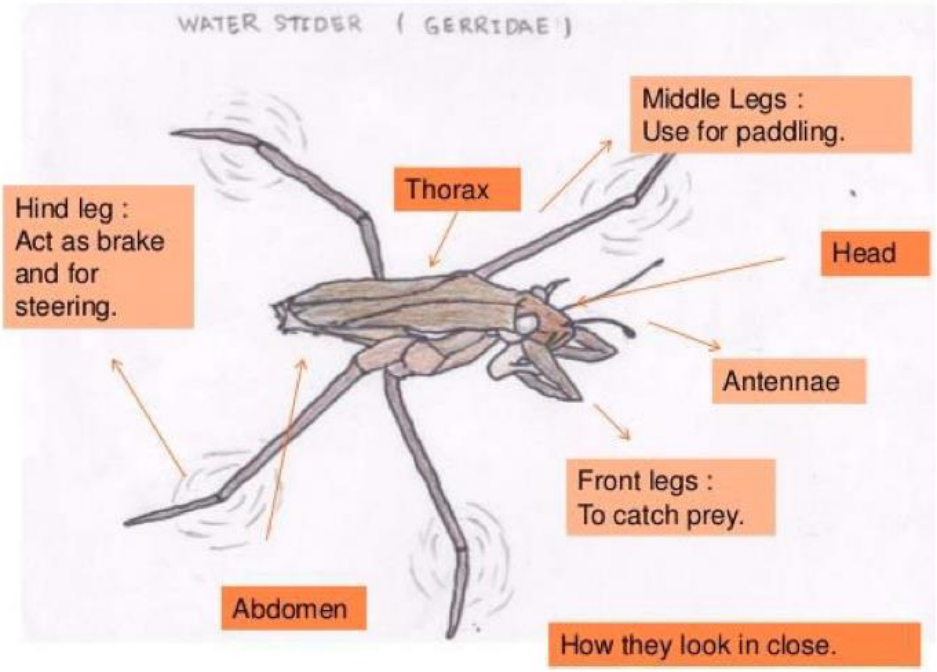
Picture 2. Portion of water strider's leg that rests in water



Picture 3. Water strider body parts and leg features.

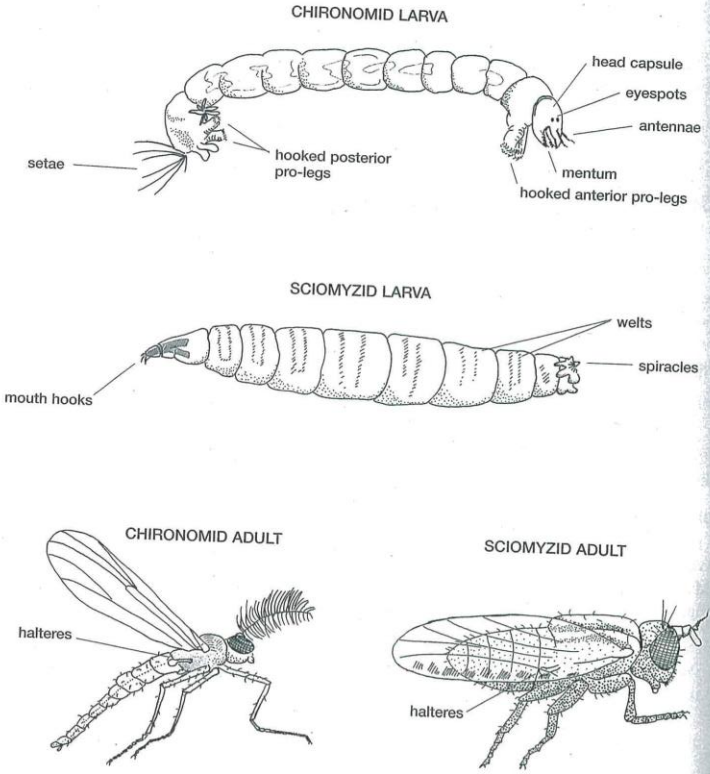


Picture 4. Water strider body parts



Flies, true flies (Order: Diptera)

The dipterans are a very diverse group of insects that occur in most, if not all of the inland waters of temperate Australia. They can be found in a range of environmental conditions, thriving in septic tanks and wilderness areas alike.



The larvae of midges (Chironomidae) and marsh flies (Sciomyzidae) provide the two extremes of body structure between which most dipterans will fit.

Fly spotting

While it is almost impossible to identify most adult flies while they are alive, some of the commoner families can be recognised by the following characters:

crane flies (**Tipulidae**): very long legs; slow cumbersome flight, long abdomens

black flies (**Simuliidae**): small, black, with rounded wings and fat little bodies

non-biting midges (**Chironomidae**): small delicate flies; males have fluffy antennae; unlike mosquitoes they keep their front legs (rather than their hind legs) in the air when resting

mosquitoes (**Culicidae**): slender bodies, fine wings and long piercing mouthparts; hind legs raised when resting

hover flies (**Syrphidae**): often orange/cream and black (wasp mimics) with hovering flight

horse flies (**Tabanidae**): large eyes (almost touching); robust bodies; piercing mouthparts

marsh flies (**Sciomyzidae**): some of the commoner swamp genera have spotty wings and a streamlined body

Characteristics of an adult fly

Adult flies have large compound eyes and a single pair of wings. Most of the other insects dealt with in this book have two pairs of wings: one on the mesothorax and the other on the metathorax. Flies have reduced their second set of wings to a pair of small knobs (halteres) and these aid in balance during flight. Diptera translates from the Greek as 'two-winged' (*di* = two, *ptera* = wings).

A diverse range of adult flies can be found near fresh water. Some of these skate on the water surface, where they scavenge or prey on dead or dying insects—a similar life to the water striders (Hemiptera). Others can be found in swarms above water, or clinging to vegetation and rocks nearby. The adults are usually agile fliers, capable of travelling long distances and this helps make many of these insects widespread if not common.

Clytocosmus (Tipulidae) is one of the larger, more brightly coloured dipterans.

Adult male chironomids have highly sensitive antennae that they use when finding females.

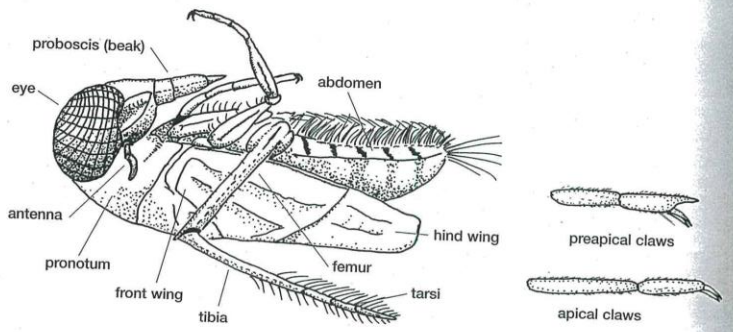
Appendix L - Gooderham, J & Tsyrlin, E 2009, *The Waterbug Book: A guide to Freshwater Macroinvertebrates of Temperate Australia*, CSIRO: Publishing, Victoria, Australia, pp.112-113.

Appendix M - Gooderham, J & Tsyrlin, E 2009, *The Waterbug Book: A guide to Freshwater Macroinvertebrates of Temperate Australia*, CSIRO: Publishing, Victoria, Australia, pp. 144-145.

True bugs (Order: Hemiptera, Suborder: Heteroptera)

Although the term 'bugs' is often used as a nickname for all insects, true bugs are hemipterans, belonging to the suborder Heteroptera. There are around 270 aquatic or semi-aquatic species in Australian inland waters—many people will have heard of backswimmers, water striders or waterboatmen.

BACKSWIMMER

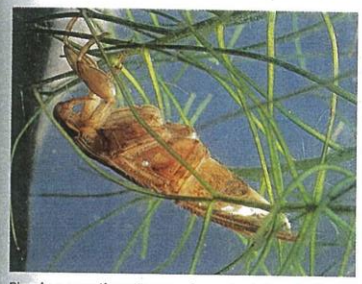


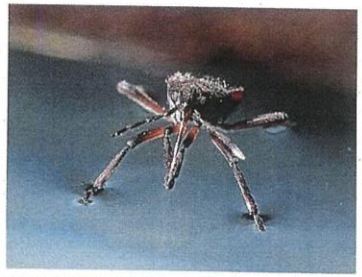
Characteristics of aquatic and semi-aquatic bugs

The hemipteran body varies from elongated and boat-shaped in backswimmers to leaf-like in water scorpions. Adult forms range from a tiny 1 mm (small water striders and velvet water bugs) to 75 mm (giant water bugs).

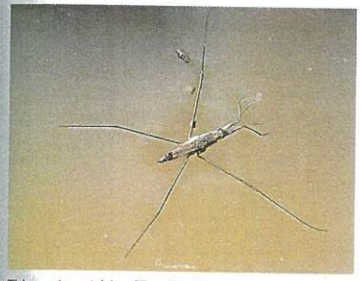
The hind legs of some families (waterboatmen, backswimmers) are widened and covered by 'swimming' hairs while the long hind and middle legs of water striders are specialised to support the animal on the surface of the water. Some groups have unusually folded forelegs specialised for grasping prey in the same manner as praying mantises.

One feature common to all aquatic and semi-aquatic bugs is their piercing and sucking mouthparts. Adults and nymphs from this group look very similar. Nymphs lack wings and are smaller.





Piercing mouthparts are characteristic of all aquatic bugs, from the 30 mm giant water bug (left) to the 1 mm small water strider (right).



This water strider (Family: Gerridae) will sink if pollutants reduce the surface tension of the water.

Members of the Ochteridae are usually found only at the edge of aquatic habitats.

Living on different levels

The true bugs are an interesting group because of the many different ways that they live in and around water. Some families such as the notonectids and corixids are fully aquatic and spend most of their time under water, while other families such as gerrids and veliids spend most of the their time on the water surface. Sometimes the surface dwellers will compete with the fully aquatic bugs for prey, and a struggling insect ensnared in the water film has an equal chance of being dragged under the water and consumed, as being plucked from the film and sucked dry above the water surface. Many more families are semi-aquatic and live along the water margins, splitting their time between the water surface and dry land. Most fully grown bugs have well formed wings and will eventually fly away from the water where they grew up, to colonise new water bodies.

Environmental significance

Hemipterans are relatively tolerant of many forms of pollution. Surface dwellers in particular have very little physical connection with water and therefore are less dependent on the water quality. However, oil and surfactants (e.g. household detergents) decrease the surface tension of the water and this reduces the ability of the surface dwellers to repel water with the hydrophobic hairs on their legs, thus causing them to sink.

Appendix N - Gooderham, J & Tsyrlin, E 2009, *The Waterbug Book: A guide to Freshwater Macroinvertebrates of Temperate Australia*, CSIRO: Publishing, Victoria, Australia, pp. 146-147.

Classification

Hemiptera is a common and diverse order. In Australia it includes over 5650 species from three different suborders. Aquatic and semi-aquatic hemipterans belong to the largest suborder Heteroptera, which includes some 270 different species from 19 different families, of which two families, Hermatobatidae and Omaniidae, are exclusively marine. Many species are endemic to Australia but most of the genera occur in other parts of the world. In this book we include 12 families that are both strongly associated with freshwater and relatively common. The Saldidae Ochteridae, Dipsocoridae, and Leptopodidae have not been included though they might sometimes be found in streams and lakes after heavy rain, while members of the aquatic Aphelocheiridae occur only in northern Australia.

Love, death and music

The males in several groups (e.g. Corixidae, Notonectidae) produce sounds to attract females. This is called stridulation and involves them rubbing the pegs on their front legs across a ridge on the front of their head. The males of some water striders (Family: Gerridae) express their feelings by making rhythmic ripples on the water.

Copulation occurs in the water or on the water surface and eggs are laid on the surface, inside aquatic plants or on the bottom of a water body. Belostomatid eggs are laid on the male's back. This protects them from both the male and other predators.

With the possible exception of some water-boatmen (Family: Corixidae) which consume a mixture of detritus and zooplankton, all aquatic bugs are predators. They use their piercing mouthparts to suck the body fluids from their prey. Surface dwellers such as water striders catch terrestrial insects that have fallen into the water; backswimmers chase small creatures in the water and water scorpions ambush their prey.

Hemipterans do not have a pupal stage and their nymphs look and behave in a similar way to the adults. Young nymphs face a real possibility of being eaten by adults and this is a good reason to stay clear of their parents.

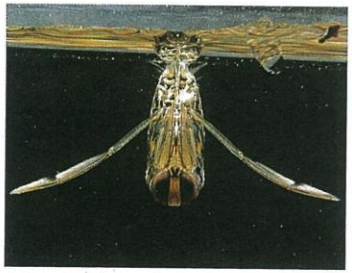
Waterboatmen make sounds by rubbing the pegs on their front legs across a ridge on the front of their head.

An immature backswimmer looks and behaves in a very similar way to an adult backswimmer.

Key to Hemiptera

1	antennae as long or longer than head, clearly visible from above; animals live on water surface or amongst fringing vegetation; semi-aquatic **2**
1	antennae shorter than head; animals live in water or around the edge of water bodies; aquatic or semi-aquatic. **6**
2(1)	body long and slender; head as long as thorax ..... **Water measurers** (**Hydrometridae**, page 153)
2	head and body stouter; head not as long as thorax **3**
3(2)	femora of hind legs extending well beyond tip of abdomen; gap between the front and mid-legs greater than that between the mid and the hind legs ..... **Water striders** (**Gerridae**, page 152)
3	femora of hind legs not extending well beyond tip of abdomen; gaps between the front, mid and hind legs are all equal; body shorter than 5 mm **4**
4(3)	winged forms with scutellum covered by the pronotum; wingless forms with pronotum covering mesonotum or not; tarsal claws preapical ..... **Small water striders** (**Veliidae**, page 159)
4	winged forms with scutellum exposed behind pronotum; wingless forms with pronotum never covering mesonotum; tarsal claws apical **5**
5(4)	hind legs longer than body length; winged and wingless forms present; tarsi 3-segmented; generally greenish or yellowish in colour ..... **Water treaders** (**Mesoveliidae**, page 159)
5	hind legs shorter than body length; only winged forms known in Australia; tarsi 2-segmented; short dense body hairs giving 'velvet' appearance ..... **Velvet water bugs** (**Hebridae**, page 159)
6(1)	antennae completely hidden; body and head broad with a pair of widely separated eyes positioned at front of head; forelegs with broad femur, specialised for grasping; semi-aquatic; up to 10–11 mm long ..... **Toad bugs** (**Gelastocoridae**, page 151)
6	without the above combination of characters; aquatic **7**
7(6)	elongate non-retractile breathing tube present at tip of abdomen; ..... **Water scorpions** (**Nepidae**, page 155)
7	abdomen without elongate breathing tube, but short, retractile air straps may be present **8**
8(7)	tarsal segments of first pair of legs scoop-like; head appearing triangular from the front ..... **Waterboatmen** (**Corixidae**, page 149)
8	without the above combination of characters **9**
9(8)	forelegs modified for grasping; swim the right way up **10**
9	forelegs are not modified for grasping; swim with ventral side up **11**
10(9)	membranous part of forewings with veins; adults 10–15 mm long; edges of body with dark and light bands ..... **Creeping water bugs** (**Naucoridae**, page 154)
10	membranous part of forewings without veins; adults around 25–75 mm long; body uniform brown ..... **Giant water bugs** (**Belostomatidae**, page 148)
11(9)	adults around 4–10 mm long; eyes large, close together; body elongated; hind legs oar-like; common. ..... **Backswimmers** (**Notonectidae**, page 157)
11	adults 2–3 mm long; eyes smaller, not close together; body highly convex; hind legs normal; less common ..... **Pygmy backswimmers** (**Pleidae**, page 158)

Appendix O - Gooderham, J & Tsyrlin, E 2009, *The Waterbug Book: A guide to Freshwater Macroinvertebrates of Temperate Australia*, CSIRO: Publishing, Victoria, Australia, pp. 158-159.



Anisops carrying a reflective bubble of air on the under side of its abdomen.

ours, which is very efficient at carrying oxygen. They can therefore carry smaller bubbles than other bugs and remain neutrally buoyant. This allows them to hunt mid-water, without sinking or constantly returning to the surface. Their upside down bodies and grasping forelegs allow backswimmers to hunt animals that have fallen on the water surface.

Backswimmers are very active predators and in the northern hemisphere there are reports of them attacking small fish. They can inflict a painful stab or bite—so handle them with care!

Pygmy backswimmers (Family: Pleidae)

Distinguishing characteristics

As their name suggests, pygmy backswimmers look very much like small backswimmers (Notonectidae). However, they have a highly convex body, are less than 3 mm long, and lack the oar-like hind legs of notonectids. They are much less common than notonectids and, due to their small size, are often overlooked in samples.

Pygmy backswimmers can be recognised by their small size, convex body and widely separated eyes.

Possible misidentifications

See Notonectidae (page 157).

Classification and distribution

Three species of the widespread genus *Neoplea* are described in Australia but only two occur in south-eastern Austrtalia.

Habitat and ecology

Pygmy backswimmers can be found in still water bodies among aquatic vegetation. Often they prefer to crawl among vegetation rather than swim. They prey on zooplankton, tiny animals smaller than themselves, and carry a bubble of air under their wings on the ventral side of their abdomen.

Natural history

Little is know about the lifecycle of pygmy backswimmers in Australia. Nymphs look similar to adults.

Small water striders, water treaders and velvet water bugs (Families: Veliidae, Mesoveliidae and Hebridae)

These three families are combined because of similarities in their appearance and habitat.

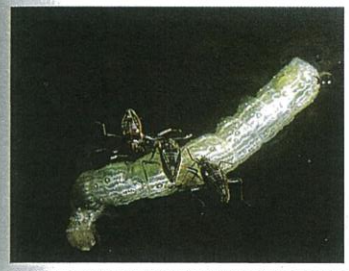
Distinguishing characteristics

These are small bugs (1–4.5 mm) with relatively short legs. Tufts of hydrophobic hair at the tip of their tarsi hold them on the water surface while in Veliidae the claws are also inserted preapically. Non-winged adult forms occur among Veliidae and Mesoveliidae, making it difficult to distinguish between immature and adult stages, but the nymphs always have only one segmented tarsi. Unlike the gerrids (water striders) which skate or scull across the water surface, members of these families either walk or run.

Possible misidentifications

Members of these families can be confused with the water striders. However, water striders have long middle and hind legs with the femora of both the middle and hind legs extending well beyond the edge of the body. Gerrids can also be recognised because the gap between their front and middle legs is greater than the gap between their middle and hind legs. Veliidae can be distinguished by preapical claws and, in winged forms,

Small water striders (Family: Veliidae) have both winged and wingless adult forms.



Small water striders (Family: Veliidae) prey and scavenge on small invertebrates fallen on the water surface.

Water treaders (Family: Mesoveliidae) have hind legs longer than their body.

the scutellum is covered by the pronotum. Hebridae and Mesoveliidae both have apical claws and the scutellum exposed behind the pronotum in winged forms. Hebridae have 2-segmented tarsi and hind legs shorter than the body, while Mesoveliidae have 3-segmented tarsi and hind legs longer than the body.

Classification and distribution

Veliidae has 12 genera and some 66 species in Australia. Five genera occur in south-eastern Australia with *Microvelia* being the most common and diverse genus.

Mesoveliidae in Australia has two genera, *Mesovelia* (widespread) and *Austrovelia* (north Queensland), but only *Mesovelia* is semi-aquatic. *Mesovelia hungerfordi* is common in south-eastern Australia.

Hebridae in Australia has two genera, *Hebrus* and *Merragata*, with one species of each common in south-eastern Australia.

Habitat and ecology

These semi-aquatic bugs are all surface or edge dwellers and can be found in still and slow-flowing waters. They prey and scavenge on small invertebrates fallen on the water surface. Like the larger water striders these groups can detect their prey by vibrations on the surface of the water.

Natural history

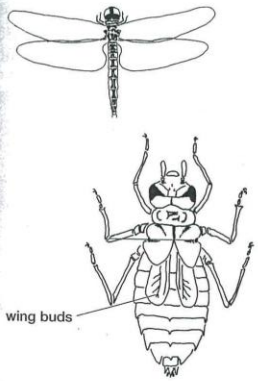
The lifecycle comprises five moults. Veliidae and Mesoveliidae have winged and wingless forms of adults while Hebridae are only known as winged forms. Winged mesoveliids are sometimes found with the membranous part of their wings ripped off. This is possibly to get the wings out of the way before mating takes place.

Dragonflies and damselflies

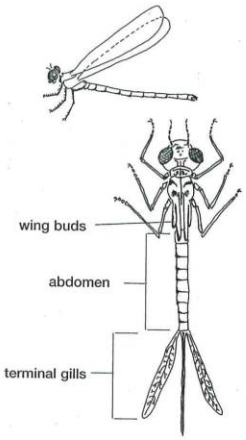
(Order: Odonata, Suborders: Epiproctophora and Zygoptera)

The odonates are one of the best-known group of freshwater invertebrates. They have a special place in human history, appearing in Japanese art, English literature, and even ancient Greek writings.

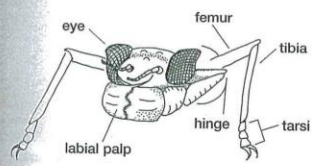
EPIPROCTOPHORA (DRAGONFLIES)



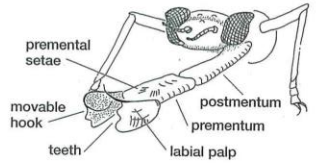
ZYGOPTERA (DAMSELFLIES)



ODONATE MOUTHPARTS (UNEXTENDED)



ODONATE MOUTHPARTS (STRIKING)



Appendix P - Gooderham, J & Tsyrlin, E 2009, *The Waterbug Book: A guide to Freshwater Macroinvertebrates of Temperate Australia*, CSIRO: Publishing, Victoria, Australia, pp. 160-161.

Chapter 6: Evaluate

Title - Let's Present and Reflect

At a glance
To provide an opportunity for the learners to recap and apply their learning through creation of a water strider using wire and creating a poster. Students will be creating a poster as a summative assessment, to be assessed against the Rubric (appendix 3) Students will create a Water Strider out of metal to reflect on learning about the features of a water strider.

AIMS OF THE STAGE:

The aims of this stage are for the students to review and reflect upon their learning and to develop further understanding of the skills that they have acquired from the engage and explore stages.

The teacher will use information from the engage stage for the students to understand the changes in their perceptions regarding Water Striders and surface tension that they had in comparison to the beginning of the unit.

SUMMATIVE ACTIVITY:

Students will :

- Design and make a water strider using three pieces of wire. Students should highlight the length and shape of legs that they have identified in the explore stage.
- Students will be divided in groups of 3 and they will create poster highlighting their observations.

LEARNING OUTCOME:

Students will be able to:

- Demonstrate understanding regarding water striders and water tension.
- Reflect and articulate on any results.
- Identify the different features of water striders that enable them to move on the surface of the water.
- Describe the interactions between water tension and the water striders.

Literacy
Students will be able to:

- Collaborate and contribute within discussions.
- Articulate and structure their results through posters and the creation of a water strider.

INFORMATION TO TEACHERS:

The poster evaluation will be based on peer-assessment. The peer assessment is conducted by one group of students representing concepts through drawings, and the other group giving titles to the drawings. The more the representations are clear and accurate, the more the preciseness of the titles given.

In the water strider activity groups of students reflect on their own understanding through continuous improvement of their models.

Depending upon your students, teachers may like to deliver the Evaluate stage over two separate sessions.

Watch the below youtube video on the creation of a water strider model (https://www.youtube.com/embed/8h7UZ8pE_Q0). Don't show the students the video, as they may simply copy it.

Guidelines For Creating Poster

- Students can recall four or more aspects of water surface tension and represents them on a poster
- The characteristics taught included: (a) water forms a layer that is held together and separates the water from the surrounding air; (b) the water surface tension tends to have a roundish shape; (c) soap breaks water tension; (d) the attraction between water particles is called cohesion; (e) the cohesion on the surface is stronger than the cohesion within the body of water; (f) When different materials adhere to each other, it is called adhesion; (g) The force of cohesion on the water surface is greater than the force of adhesion between the water and air above; (h) The strength of water cohesion can be measured; and, (i) cold water have stronger cohesion force that warm water.

  Students will have access to the materials such as their journals and the TWLH chart that contain information they can use on their posters.

Guidelines for Creating Water Strider

Present students with diverse materials, including a bottle of oil, cotton threads (Students could dip them in oil and try attach them as hair), glue, pipe cleaners (students may try to dip them with oil and see if it works. If they are too heavy, perhaps they can attach small pieces dipped in oil, to the copper wire, as feet endings). Add plates and water for testing.

EQUIPMENT:

Water Strider	***Poster Making***
Thin copper wire Scissors Food coloring optional Bottle of Oil Cotton Threads Glue Pipe Cleaners Plates Water	Butchers paper Markers Glue Paint Photographs from excursion

LESSON STEPS:

1. The teachers explains to students that today we reflect on the learning in the unit and represent our understanding in two activities. In the first activity group of students will work together to develop a poster. In the second activity, students will form new groups in which they will build a water strider.

Poster development activity

2. Explain to students that in this activity they are asked to represent their understanding of water surface tension. They will need to follow a set of instructions when developing the posters.

3. Prepare the class by having students seated around tables in groups of four. Each group receives a butcher paper. Ask the students to use a range of materials to develop their posters. These include: colored markers, pencils, scissors, they may also download pictures from the computer, print them and paste them on the poster.

4. Guide students' work through the following set of instructions:

a. Carefully read through your science journal, TWLH, Investigation Recording sheet, and Excursion Observation Protocol.

b. Select four characteristics of surface water tension and write them in your science journal. For example: The roundish shape is a characteristic. Cohesion is a characteristic.

c. Use drawings, photographs, and colouring pens to represent the four characteristics you chose. Your drawings and pictures should convey the characteristics clear enough for someone else to understand. Do not write any explanations, or words on the posters.

d. When students complete their drawings, ask each group to pass their poster to the group sitting next to them.

e. Ask each group to view the four drawings on the poster of their peers and identify the characteristic that is represented by each drawing.

f. Ask students to write a title above each drawing, describing the identified characteristic.

g. Once title writing is completed, students return the posters to the original groups.

h. The original groups review the titles given to their drawings, and report to class how many drawings were identified correctly.

i. The more drawings identified correctly, the more accurate were the representations. Students receive scores according to the number of drawings identified correctly.

Water strider activity

5. The teacher rearranges students in new groups of four.
6. Explain to students that they are now going to build a water strider that can actually stay on water without breaking the surface tension.
7. Each group of students is given the materials listed under Equipment.
8. Before students begin the activity, instruct them to review their TWLH chart and Excursion Observation Protocol.
9. After reviewing the materials, ask students: What features allow water striders to walk on water?
10. Ask students to apply these features in constructing their water strider.
11. Tell the students that they will each receive a bowl of water. They are welcome to make as many trials as they wish until they manage to get their water strider to stay on the water.
12. When most students achieved the goal, bring the class together to reflect on the process.
13. Ask each group to describe what went well, what didn't work and what changes they had to make in order to improve their model.
14. Ask students what scientific facts were applied in building their models.

Alignment to Victorian Curriculum:

• SCIENCE UNDERSTANDING	• SCIENCE INQUIRY SKILLS
Biological Sciences (VCSSU074) Living things have structural features and adaptations that help them to survive in their environment.	**Communicating** Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships(VCSIS088)

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