ASELL SCHOOLS
Advancing Science & Engineering through Laboratory Learning

ASELL for Schools Workshop

Laboratory Learning Activity Manual

North Geelong Secondary College

13 December 2016

ASELL SCHOOLS Advancing Science & Engineering through Laboratory Learning
Australian Council of Deans of Science
ReMSTEP
Australian Government Department of Education and Training Office for Learning and Teaching
DEAKIN UNIVERSITY

CONTENTS

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WELCOME

Welcome to an ASELL for Schools Workshop!

ASELL (Advancing Science and Engineering through Laboratory Learning) has developed over the last 10 years. This project developed from its physical chemistry APCELL predecessor and then expanded to incorporate all of chemistry (ACELL). After successful trials of using ASELL principles at workshops in physics and biology, the project has now expanded to include biology and physics, and more recently engineering, hence the name change.

The ASELL project has been designed to help address challenges in student learning which arise in science laboratories. By bringing together diverse expertise and resources, it is possible to develop a collection of experiments, which can facilitate student learning, whilst also taking into account variations in student differences. In 2010, the first national ASELL Science Workshop was held at the University of Adelaide.

This ASELL for Schools workshop is the second Victorian workshop to be run under the Australian Mathematics and Science Partnership Funding Grant, which was awarded to ASELL in 2014. This phase of the project has been initiated by Deakin University in conjunction with the University of Sydney with support from ReMSTEP and the Australian Council of Deans of Science. With the introduction of the new Australian and Victorian Curricula now in place, an opportunity exists to address current school-based experimentation and incorporate science inquiry. ASELL for Schools will provide the following three outcomes:

- A resource, a repository of experiments with all associated documentation necessary to run them, ranging from health and safety notes, necessary equipment and resources, notes for technical staff to the science learning objectives and how the experiment achieves them.
- Authentic professional learning workshops on experimentation in schools.
- An interface and interaction between school and university staff.

Today, you will be participating in laboratory activities and discussion sessions to expand your understanding of issues surrounding learning in the laboratory environment. In particular, it is important to be able to experience the experiments as learners.

In addition to the formal program, please take the opportunity to exchange ideas about science and education and get to know each other, as an additional aim of the ASELL for Schools project is to build a community of educators interested in laboratory-based education and other aspects of science education.

We would like to gratefully acknowledge the efforts of the submitters in presenting their experiments, as well as the assistance of technical staff and others in making this workshop possible. A very big thank you to the team at North Geelong Secondary College, for hosting this Workshop. Each person has put in a lot of hard work to get this workshop set up and running. I want to thank everyone!

If you have any questions about the project, please speak with me or one of the Victorian ASELL for Schools team, who are present.

Sincerely,

Kieran Lim

Kieran Lim
ASELL for Schools Victorian Leader, on behalf of the ASELL for Schools Team

ASELL FOR SCHOOLS WORKSHOP SCHEDULE

ASELL for Schools North Geelong Secondary College *Tuesday 13 December 2016*		
9:00–9:15	**Arrival/Registration**	
9:15–9:30	**Welcome and Introduction** with Dr John Long • Introductions (of ASELL for Schools team and Students and Teachers) • Outline ASELL for Schools project – how to be involved?	
9:30–10.00	**Teachers: Inquiry in Science** with Dr Peta White • How can we incorporate more science inquiry into experiments? • Introduction to the inquiry slider	**Students: Pre Lab Session** with Ian Bentley • Forces and failure
10:00–10:40	***Laboratory learning activity 1 – Materials Testing: Adhesives*** *Mr Ian Bentley and Dr John Long*	
10.40–11:00	**Morning Tea** ***Venue School library***	
11:00–11:20	***Laboratory learning activity 1 – Materials Testing: Adhesives*** *Mr Ian Bentley and Dr John Long*	
11:20–11:40	Discussion and feedback on Laboratory learning activity	
11:40–12:20	**Teachers: Unpacking a GREAT ASELL for Schools LLAs** with Dr Peta White What does a GREAT ASELL for Schools LLA look like? Science Inquiry skills, direct inquiry, representation construction pedagogy, and contemporary science	**Students: Interview with a scientist** with Mrs Jorja McKinnon (citizen science)
12:20–12:50 *	***Laboratory learning activity 2 – Fill the Bill*** *Dr Peta White, Mr Ian Bentley and Mr Oliver Reeve*	
12:50–1:30 *	**Lunch** * Workshop lunch starts 10 minutes later than school lunch. ***Venue School library***	
1:30–1:55	***Laboratory learning activity 2 – Fill the Bill*** *Dr Peta White, Mr Ian Bentley and Mr Oliver Reeve*	
1:55–2:15	Discussion and feedback on Laboratory learning activity	
2:15–3:00	**Teachers:** Overall debrief and Evaluation for the day with A *Dr Peta White*	**Students:** Overall debrief and Evaluation for the day with Dr John Long

LABORATORY LEARNING ACTIVITY MATERIALS TESTING: ADHESIVES. PART A. UNDERSTANDING GLUES AND ADHESIVES

Contact: Ian Bentley
i.bentley@deakin.edu.au

L A B O R A T O R Y L E A R N I N G A C T I V I T Y

Materials Testing: Adhesives. Part A. Understanding glues and adhesives

Introduction

Glues and adhesives are a common part of everyday life. We use them to stick things in a book, on a wall, or to repair a broken item.

<pixabay.com/en/repair-glue-fix-adhesive-891422/>

The desk you are sitting at probably has a plastic laminate surface glued to a particleboard plank. If you are in a room with plaster walls, the plaster board has probably been glued to the building frame.

An important component of composite materials such as carbon fibre and fibre glass use glue, usually called a resin. When the resin dries (cures), the fibres stick together making a very hard and strong material. Even particleboard is a composite material made of woodchips and a glue called formaldehyde resin.

Carbon fibre is a potential replacement for metal parts in many products. It is strong and light but currently it is expensive and slow to manufacture. Materials scientists are trying to make carbon fibre cheaper, stronger and faster to make. One of the keys to improving carbon fibre production is understanding how adhesives work.

<www.3domwraps.com/media/32895/aston-martin-carbon-fibre-vinyl-wrap.jpg>

In this activity, you are going to investigate how adhesives stick things together. You will be able to give a scientific explanation of the problems that the materials scientists are trying to solve in their research on carbon fibre manufacture.

Key ideas

Adhesion (force) – adhesion is the name given to the tendency of one substance to stick to another substance such

as glue to paper or water to glass. A rain droplet sticks to a window by adhesive forces.

<pixabay.com/en/drops-pane-rain-rain-drops-906019/>

Cohesion (force) – cohesion is the tendency of a material to hold together and not fall apart. Cohesive forces are the pulling forces between the particles of the material that hold it together. Cohesion between water molecules holds a drop of water together.

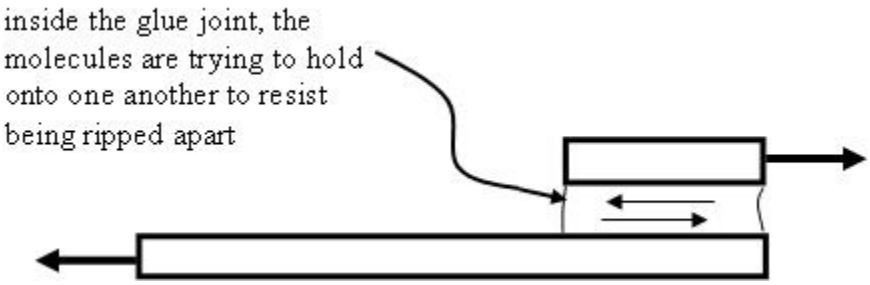
Surface – in this activity the word surface is used to refer to the part of the object or material to which the glue is applied.

Surface area – is the total area of the surface of an object. When thinking about glues we are interested in the total surface to which the glue is attached. If a surface is roughened up its surface area increases.

Force – we know that forces are pushes or pulls. Forces can be seen at the level of people's actions such as when a person pushes a trolley. But forces also operate at the level of the particles inside materials. Forces between the particles attract them to one another. The stronger the forces the stronger and harder the material.

Load – the force applied to an object.

Shear – two adjacent pushing or pulling forces, acting close together but in opposing directions, cause a shearing load.



<www.teachengineering.org/lessons/view/wpi_lesson_1>

Shear strength – the shear load required to break an object or joint.

Failure – the breaking of a material exposed to external force such as when a rope being used to tow a car breaks, or when you bend a stick till it breaks.

Part A1 Strength of adhesion to different surfaces

In this activity, you will investigate the question: "To which surface does Blu-Tack stick best, wood or plastic?"

Materials

- A small piece of Blu-Tack about 6 mm in diameter. [Footnote 1]
- 2 icy pole sticks (one with a hole in one end) [Footnote 2]
- 2 plastic strips (one with a hole in the end)
- Slotted brass weights – about 500 g
- Sand paper

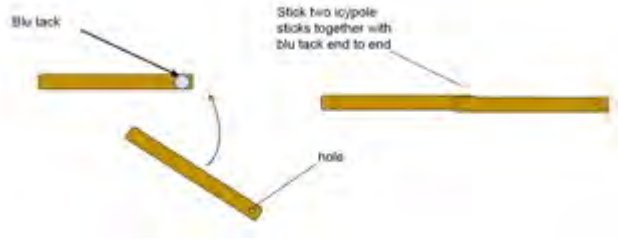
1 Blu-Tack is the commercial name of a "reusable" adhesive made by Bostik. Other similar products can be used.

2 Icy pole stick, paddle pop stick, and popsicle stick are alternate names for flat pieces of wood about 12 cm long, 1 cm wide, and 2 mm thick. Any similar product can be used.

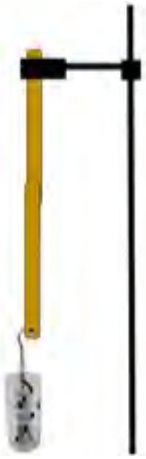
Procedure

The instructions given here contain some of the things you need to do for the test. Read the instructions and try the test out before you start recording results. Identify and record what you need to do to make the test a **fair test**.

1. Stick the other two icy pole sticks together as shown so that they overlap by a distance equal to the width of the stick.



2. Suspend glued icy pole sticks from clamp on a stand as shown



3. Hang a 50-gram brass weight through hole in icy pole stick. Progressively add weight until the joint breaks. Record in the Results table the load at which the joint fails.

4. Closely observe the fractured Blu-Tack surface. Describe or draw the result in the Observations section below.

5. Repeat the tests with the icy pole sticks and record your results.

6. Repeat the tests using the plastic strips. Record your results and observations.

7. Using the sand paper roughen the surface on the end of one piece of plastic and repeat the tests. Record your results and note your observations.

Fair test

Write here what you need to do to make the test fair.

Results

Test	Suspended mass (g)		
	Wood	Smooth plastic	Rough plastic
1			
2			
3			

Observations

Your drawing or description of the broken Blu-Tack joint.

Conclusions

What conclusion can you draw about the tensile strength of Blu-Tack compared with its shear strength.

Representations

Use labelled diagrams to represent what happened in this experiment.

Draw a labelled diagram to show how the particles inside the Blu-Tack stuck the two icy pole sticks together. Use the terms adhesive forces and cohesive forces. *Hint: In your drawings represent the way the* Blu-Tack *stuck to the wood? Show how the* Blu-Tack *sticks to itself?*

Draw a labelled diagram to explain the effect of roughening the surface of the plastic.

Part A2 Comparing Blu-Tack with Tuff Tacks

An office supplies chain has a produced a cheaper form of Blu-Tack. Devise and carry out a test to determine whether the new and cheaper product is as good as the original adhesive.

What variables are important in your test?

What will you measure? What will you keep the same?

Describe your Procedure.

Record your results

What is your conclusion?

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LABORATORY LEARNING ACTIVITY MATERIALS TESTING: ADHESIVES. PART B. MAKING AND TESTING GLUES

Contact: Ian Bentley
i.bentley@deakin.edu.au

L A B O R A T O R Y L E A R N I N G A C T I V I T Y

Materials Testing: Adhesives.
Part B. Making and testing glues

Introduction

There are many types of glues for different types of jobs. Glues differ:

- in the degree to which they adhere when 'dried' to different surfaces
- in their flexibility, their strength (i.e. the strength of the cohesive forces within the 'dried' glue) and
- in their solubility in different liquids.

Key ideas

Glues are usually liquid when they are applied but become solid when they dry or cure. The process of becoming solid or more solid can occur in several different ways. The glue dries or sets when:

1. the solvent or liquid part of the glue evaporates. This happens with the traditional glue called clag that is made of starch and water. Modelling glues also work in this way but the solvent is usually something other than water that evaporates very quickly.
2. a chemical reaction (polymerisation) occurs. The molecules of the glue form chemical bonds with one another. This is what happens in 'two part' glues. These glues have one part called the resin and another called the hardener.
3. the glue cools, such as when the hot glue from a hot glue gun cools.

Different glues work better on different surfaces, so in this activity we will compare how well the glues work on wood, plastic and paper.

Curing – the name given to the hardening of a glue where a chemical reaction causes bonds (strong attractive forces) to form between the particles

Drying – some glues harden because the solvent (liquid part) evaporates.

Hazards

Wear gloves and eye protection.

Temperature hazard – When making glues they will be hot and sticky.

Dropping weights – be careful when testing your glues that weights don't drop on your hands or feet

Activity B1 Making Glues

Recipes for four different glues you can make at home or in the laboratory.

Materials

- Strips of paper and cardboard.
- Icy pole sticks.
- Ingredients for making the glues.
- Heat source.
- Stirring rods or spoons.
- Beakers or glass jars or cups.

Your group will be assigned one of the following glues to make. Use the ingredients provided and follow the instructions

Corn syrup glue

- Corn syrup

- White vinegar
- Corn-starch

1. In a small saucepan, mix 180 mL water with 35mL corn syrup and 15mL tablespoon white vinegar.
2. Bring the mixture to a rolling boil.
3. In bowl, mix 20g corn-starch with 180 mL cold water.
4. Slowly add the cold mixture into the hot mixture. Stir constantly for one minute.
5. Remove from heat.

Once it has cooled, pour the mixture into a labelled glass jar or beaker or cup.

(Let it stand overnight at room temperature before using.)

Casein glue

- gelatine [Footnote [1]]
- skim milk
- clove oil (optional)

This glue can stick glass together, use it in its gelled (room temperature) state.

1. Pour two tablespoons of cold water into a small bowl.
2. Sprinkle 2 packets of unflavoured gelatine over the water and set aside for about an hour.
3. Heat 40 g skim milk to just below boiling and pour it into the gelatine and water.
4. Stir the mixture until the gelatine is completely dissolved.

Optionally, add a few drops of clove oil as preservative if you're not going to use all the glue immediately. (With clove

[1] Gelatine and gelatin are alternate spellings for the same substance.

oil, the glue will keep for a day or so – when it starts smelling like spoiled milk, throw it out.)

Gum Arabic glue

- 45 mL gum arabic
- 15 mL glycerol [Footnote 2]
- 8 mL water

1. Mix 45 mL gum arabic, 15 mL glycerol and 8mL water thoroughly in a bowl or beaker.

2. To use this glue, apply a thin coat to each surface and hold the pieces firmly together until the glue dries. (up to an hour)

Gelatine glue

- 1 packet gelatine (10 g)
- 15 mL glycerol
- 15 mL white vinegar
- 60 mL water

1. Add the gelatine to 15 mL cold water in a beaker, stir gently, let stand until it 'blooms'

2. Mix 45 mL boiling water, the white vinegar, and glycerol to the gelatine and stir until it all dissolves.

The resultant glue may become solid and will need to be warmed to soften before each use.

Activity B2 Testing Glues

Which is the best for gluing wood, plastic?

In designing your fair test, you need to identify the important variables.

[2] Glycerol, glycerin, glycerine, 1,2,3-propanetriol, propan-1,2,3-triol and propane-1,2,3-triol are all alternate names and spellings for the same chemical substance. Glycerol is the official IUPAC (International Union of Pure and Applied Chemistry) name. Propan-1,2,3-triol is the systematic IUPAC name. Glycerin is a commonly used commercial name.

What variable will you change? (independent variable)

What variables will you keep constant? (controlled variables)

What variable will you measure?

Record the load needed to break the glue joint and record it in your table

Examine the surface of the break. Has the glue separated from itself or has it come away from the surface of the glued object?

Repeat this procedure using strips of rigid plastic.

Results

	Failure load (g)	
Glue name	Wood	Plastic

Analysis

Draw a graph or chart using the data from your results table

Discussion and Conclusions

Which of the glues is best for gluing each of the materials, wood and plastic?

What evidence are you have for your claim?

How confident are you in your conclusions? Is there any doubt in your mind? Why?

How could you improve your testing procedure to achieve more reliable results?

Extension

Devise a test to measure the effectives of the different glues on paper.

Design an investigation to test whether the glues are waterproof.

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LABORATORY LEARNING ACTIVITY 2
FILL THE BILL

Contact: Peta White
peta.white@deakin.edu.au

LABORATORY LEARNING ACTIVITY

Fill the Bill – Bird Adaptation and Habitat Inquiry

Purpose

Living things have specialised diets and specialised body parts to match. The way that birds' beaks match their diet is a great example. A sparrow can't swallow a mouse and an eagle can't eat nectar from a flower. In this activity, you will use different tools to pick up different types of "food" and find out which bird beaks work best for tearing, scooping, cracking and picking. Using the Atlas of Living Australia, you will also investigate the distribution of some bird species in your locality with beaks that are especially suited to certain types of food.

Background

Species are adapted to the environments in which they live. That's partly why protecting habitats is so important: a species is perfectly adapted to its own habitat's unique types of basic components – food water shelter and space to raise young.

Activity 1

Procedure

This activity is designed to allow you to model different beaks and how they work with different food. Modelling is often used by scientists to generate knowledge.

You will find around the room a series of stations at which you will find simulations of different food sources together with a range of tools to access the food.

Your task is to work out the best "tool" to use for each food type.

Station	Description	Tools
1	Water in a tall, narrow vase to represent nectar in a flower.	Eyedropper or straw*, envelope or small fishnet, large scoop or slotted spoon
2	Large container filled with dry oatmeal, with fake worms on the bottom to represent worms buried in the mud.	Chopsticks or forceps*, nutcracker, strainer
3	Whole walnuts or other nuts to represent seeds with hard coverings.	Nutcracker or pliers*, tongs, chopsticks
4	Styrofoam "peanuts" (or dried macaroni) floating in an aquarium filled with water to represent fish and other aquatic animals.	Large scoop or slotted spoon*, eyedropper or straw, chopsticks
5	Puffed rice in an aquarium filled with water to represent tiny aquatic plants And animals.	Strainer*, forceps or tweezers, tongs
6	Popped popcorn or small marshmallows tossed in the air (by a partner or booth assistant) (which must be caught while in the air) to represent flying insects.	Envelope or small fishnet*, forceps or tweezers, chopsticks
7	Rice spread on a log to represent caterpillars and other insects.	Forceps or tweezers*, envelope or small, fishnet, nutcracker or pliers
8	Cherries hanging from a string to represent fruit hanging from a branch.	Tongs*, eyedropper or straw, strainer

(Source: Flying Wild, 2011)

Results

Station	Best Tool
1	
2	
3	
4	
5	
6	
7	
8	

Conclusions

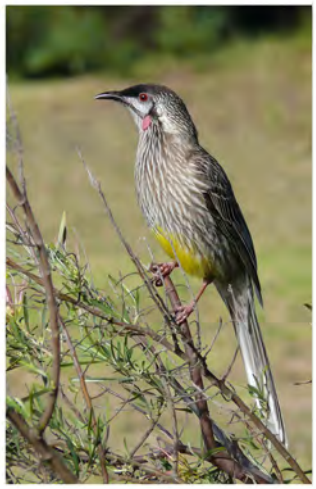
Based on your findings draw a beak shape that would best suit each type of food.

Food	Best beak shape
Nectar	
Worms in mud	
Seeds	
Fish	

Food	Best beak shape
Tiny aquatic plants and animals	
Flying insects	
Caterpillars and insects	
Fruit	

Here are some birds found in your locality. The food they eat is shown.

Cracticus torquatus: Grey butcherbird
Insect and caterpillars



Anthochaera carunculata: Red Wattlebird
Nectar

Cacatua galerita: Sulphur-crested cockatoo
Seeds

Rhipidura leucophrys: Willie wagtail
Flying insects

Turdus merula: Common blackbird
Worms

Pelicanus conspicillatus: Australian Pelican
Fish

Manorina melanocephala: Noisy miner
Nectar, seeds and fruit

Anas platyrhynchos: Common Mallard
Tiny aquatic plants and animals

How do their beaks compare with your drawings?

To what extent do you think this modelling activity allows you to understand bird beak adaptation?

What do these models **not** show about bird beak adaptation?

How do these activities represent the way that scientists study adaptations?

Can you link this modelling activity to the scientific practice of palaeontology (scientists interpreting dinosaur fossils)?

Activity 2

Scenario

You have been asked by the Geelong City Council to advise on setting aside up to ten percent of land in the Geelong area for bird conservation. In your report to the council you need to state what areas you would set aside and justify your advice with evidence.

Procedure

Go to the Atlas of Living Australia http://www.ala.org.au/
Click the browse location tile and type the Geelong into the Search field
Set the radius to 10 km
Use the list under the heading Species: Common Name to find each of the birds listed on the previous page. Find how many recorded sightings there have been of each bird and describe the habitat/s in which the bird has been sighted.

Results

Bird	No of records	Habitat/s
Anas platyrhynchos Common Mallard		
Manorina melanocphala Noisy miner		
Turdus merula Common blackbird		
Pelicanus conspicillatus Australian pelican		
Rhipidura leucophrys Willie wagtail		
Cacatua galerita Sulphur-crested cockatoo		
Anthochaera carunculata Red wattle bird		
Cracticus torquatus Grey butcherbird		

Except for the Mallard the birds listed so far are relatively common. Look through the list and pick out 6 birds that are rare (10 – 30 recorded sightings). List these rare birds in the blank parts of the table together with their habitats.

Bird	No of records	Habitat/s

Summary Report to Geelong Council

Activity 3

In developing your report to the council, you have consulted a scientist who has advised against you using some of the information on the birds recorded in the Atlas of Living Australia. The scientist said that the dots on the maps are not an accurate representation of the distribution of the birds, that some of the information is unreliable and out of date.

Procedure

The scientist has provided a list of birds in the table below as evidence of her claims. Examine the list of records and identify how recent the sightings of the birds were made and who has recorded those sightings.

	Dates of records Number of different	Useful data for report Yes/No
Regent honeyeater		
Australian bustard		
Rufous songlark		
Rainbow bee-eater		
Australian king parrot		
Chicken hawk		

Decide whether you think that the information on the location of each bird is current and reliable enough to use in your submission to council.

Conclusions

Choose one of the above that is unreliable. What could be done to generate more accurate data about

a) Distribution

b) Habitat

If a scientist is to work for the Geelong City Council in recommending habitat management what range of things should they consider? Eg: food sources. What else?

A local Councillor objects to spending money on bird preservation. He suggests that the money would be better spent on upgrading the football ground/facilities. How would construct an agreement in support for bird preservation?

Citizen Science

Citizen Science is where local residence and interested people collect data as part of scientific projects. Often this involves scientists training the citizens to collect and record accurate data.

Have you or anyone you know been involved in citizen science activities? Describe what you did.

What sort of scientific activities might citizens be interested in?

References

Flying Wild: an educator's guide to celebrating birds. (2011). Council for Environmental Education. Houston, Texas.
http://www.waderquest.org/2016_01_01_archive.html

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