ASELL for Schools Workshop

Laboratory Learning Activity Manual

Emmaus College

21 June 2017

CONTENTS

ACKNOWLEDGEMENTS

We would like to thank:

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 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 assistance of teachers, technical staff and others in making this workshop possible. A very big thank you to the team at Emmaus College, for hosting this Workshop. Everyone 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 Emmaus College Wednesday 21 June 2017		
8:45-9:00	**Arrival/Registration** ***Venue FL5***	
9:00–9: 15	**Welcome and Introduction** with Karen Daniels and Kieran Lim • Introductions (of ASELL for School team and Students and Teachers) • Outline ASELL for Schools • Outcomes for the day • How to use the booklet ***Venue LabFL5***	
9: 15-9:25	Introduction to Laboratory Learning Activity ***Venue Lab FL5***	
9:25-10:25	***Laboratory learning activity 1 – Crash Test Dummies*** *Ian Bentley and John Long* ***Venue Labs FL4 and FL5***	
10:25-10:35	**Teachers:** Inquiry Scaffolding tool Ian Bentley ***Venue Lab FL5***	**Students:** Discussion about distance, time and speed Kieran Lim ***Venue Lab FL4***
10:35-11:00	**Morning Tea** ***Venue Lab FL5***	
11:00-11:10 11:10-12:15	**Teachers:** Discussion and feedback on Laboratory learning activity Aims of ReMSTEP/ASELL LLAs; Analysis of a current Laboratory Learning Activity Ian Bentley ***Venue Lab FL5***	**Students:** Data analysis Kieran Lim ***Venue Lab FL4*** **Students:** Discussion and feedback on Laboratory learning activity John Long and Kieran Lim ***Venue Lab FL4***
12:15-12:25	Introduction to Laboratory Learning Activity Karen Daniels and Kieran Lim ***Venue Lab FL5***	
12:25-12:45	***Laboratory learning activity 2 – If the Shoe Fits*** Karen Daniels and Kieran Lim ***Venue Labs FL4 and FL5***	
12:45-1:35	**Lunch** ***Venue Lab FL5***	
1:35-2:20	***Laboratory learning activity 2 – If the Shoe Fits*** (continued) ***Venue Labs FL4 and FL5***	
2:20-2:40	Discussion and feedback on Laboratory Learning Activity **Teachers:** ***Venue Lab FL5***	**Students:** ***Venue Lab FL4***
2:40-3:00	Overall debrief and Evaluation for the day **Teachers:** Kieran Lim ***Venue Lab FL5***	**Students:** Peta White and John Long ***Venue Lab FL4***

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

LABORATORY SESSION 1
CRASH TEST DUMMIES

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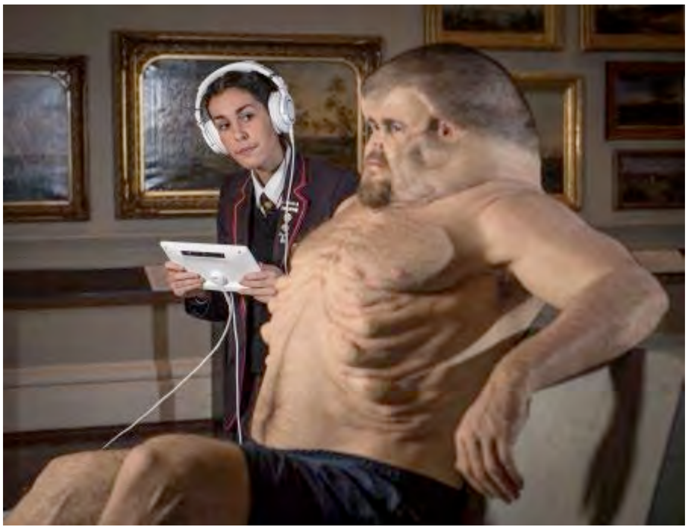
Crash Test Dummies

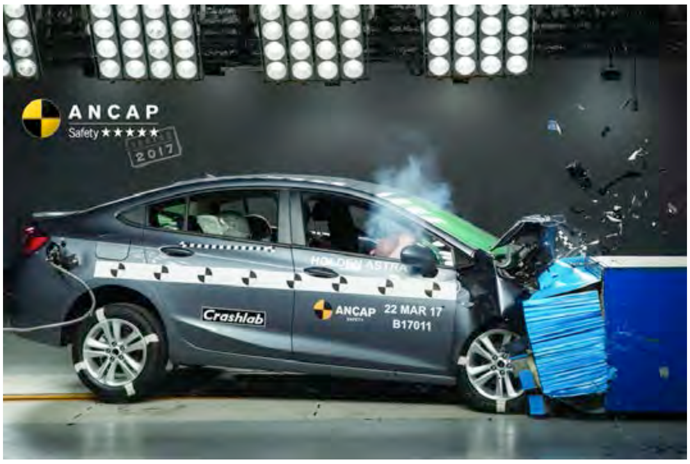
Introduction

One of the key elements of modern automobile design is crashworthiness, or how likely someone in the car will survive if the car is in a crash. Forty years ago, cars were designed to withstand a crash with as little damage to the car as possible. Now cars are designed that the car takes the damage in an accident, not the driver and passengers.



Students exploring Graham. Photograph © Transport Accident Commission.
http://www.tac.vic.gov.au/about-the-tac/media-room/news-and-events/current-media-releases/introducing-graham

The Transport Accident Commission has collaborated with Royal Melbourne Hospital trauma surgeon, Christian Kenfield, Monash University Accident Research Centre crash investigator, David Logan, and Melbourne sculptor, Patricia Piccinini, to produce ‘Graham’, an interactive lifelike sculpture demonstrating bodily features that might be present in humans if they had evolved to withstand the forces involved in crashes. Studies have shown that the human body can only cope with impacts at speeds people can reach on their own, unassisted by vehicles.



Holden Astra (May 2017 – onwards) frontal offset test at 64km/h.
Photograph © Australasian New Car Assessment Program (ANCAP).
http://www.ancap.com.au/safety-ratings/holden/astra-25ad9072-b3da-4fb0-863e-37045a3cac7c/4fc8d4/images-and-video

In this activity, you are an automotive test engineer. Your task is to investigate what happens to someone in a car during a crash. You will do this by taking high-speed video footage of different kinds of crashes and examining what happens to the occupant during the crash. You will also take some measurements of how far a driver flies out of the car when it crashes into a barrier at different speeds. You will also investigate the effect that adding a crumple zone on the front of the car has on the motion of the occupant during a crash.

Key ideas

Force – a push or a pull

Newton's First Law – Objects at rest stay at rest. Objects in motion stay in a straight line motion unless subjected to an unbalanced force.

Newton's Second Law – The net force acting on an object is equal to the mass of the object multiplied by its acceleration:
$F=ma$

Newton's Third Law – When one object exerts a force on a second object, the second object exerts an equal and opposite force back on the first object.

Kinetic energy – Energy that an object has by virtue of its motion.

Crumple zones – Parts of a car designed to take the hit so that the occupants are protected. The crumple zone absorbs the kinetic energy instead of the driver.

Materials

- Trolley
- Beanie teddy bear (driver or passenger)
- 2-metre ramp
- Obstacle to crash into.
- Go-Pro camera or a modern I-phone with a high-speed camera.
- Computer with VLC media player (or equivalent) installed
- Cardboard for making a seat and a crumple zone.
- Sheets of photocopy paper
- Sticky tape.
- Blu-tack (or similar)
- Tape measure
- Stopwatch

Part A: Motion of a passenger in a crash

In this experiment, teddy is a passenger at the back of the car and the car crashed into a wall. Ted is not wearing his seatbelt. What happens to Teddy during the crash?

Part A: Procedure

1. Using the supplied cardboard and sticky tape, construct a seat for Ted so that he does not fall off the trolley before the collision.

2. Construct a ramp for the trolley to run down. Use more cardboard to make a smooth transition between the ramp and the floor.

3. Use a motionless obstacle, like a brick, for a crash barrier to stop the trolley.

4. Run Ted and the trolley down the ramp and crash it into the crash barrier.

5. Video-record the collision with a high-speed camera. Place a stopwatch in the view of the camera to monitor time.

6. Perform the crash for three different heights of the ramp, corresponding to three different impact speeds – slow, fast, and fastest.

Part A: Data Analysis

1. Draw a picture of your ramp and crash barrier.

2. Study the video footage in slow speed. For each ramp height, describe below the motion of the trolley and Ted during the collision.

3. From the stopwatch data, determine the average time it takes for the trolley to stop and Ted to stop.

4. Describe how Newton's laws apply in the collision. For one crash, how many collisions are there?

Part B: Motion of a driver in a crash

In this experiment, teddy is the driver at the front of the car and the car crashes into a wall. There is no windscreen and no seat belt. What happens to Ted during the crash?

Part B: Procedure

1. Using the supplied cardboard and sticky tape, construct a seat for Ted so that he does not fall off the trolley before the collision, and the seat is at the same level as the front bulkhead of the trolley.

2. Construct a ramp for the trolley to run down. Use more cardboard to make a smooth transition between the ramp and the floor.

3. Run Ted and the trolley down the ramp and crash it into a motionless obstacle, like a brick.

4. Video-record the collision with a high-speed camera. Place a stopwatch in the view of the camera to monitor time.

5. Perform the crash for three different heights of the ramp, corresponding to three different impact speeds – slow, fast, and fastest.

6. For each ramp height, measure how far Ted flies away from the trolley.

Part B: Data Analysis

1. Study the video footage in slow speed. For each ramp height, describe below the motion of the trolley and Ted during the collision.

2. From the stopwatch data, determine the average time it takes for the trolley to stop and Ted to stop.

3. Describe how Newton's laws apply in the collision.

4. Determine the pattern between ramp height and how far Ted travels from the site of the collision and where he stops.

Part C: Effect of a crumple zone

In this experiment, you will add a crumple zone to the front of the trolley. Does the crumple zone lessen the impact on Ted?

Part C: Procedure

1. Using the supplied materials and sticky tape, construct two different crumple-zone bumpers for the trolley. One is paper, one is cardboard.

2. Repeat the previous two investigations with the different crumple zones.

Part C: Data Analysis

1. Draw a picture of your paper crumple-zone bumper.

2. Draw a picture of your cardboard crumple-zone bumper.

3. Study the video footage and measurements in slow speed. For each ramp height, determine if the crumple zone gave Ted any protection during the crash. Which material made the more effective crumple zone? For instance, when Ted is the passenger, Is there any change to his motion during the collision? When Ted is the driver, does he fly as far during the collision?

Part D: A two-trolley collision

In this experiment, one trolley with Ted1 as passenger collides with the rear of a second stationary trolley with Ted2 as the driver. During the collision, what happens to both Teds?

Part D: Procedure

1. Design and perform an experiment to determine what happens in a rear-end collision. The driver of the front trolley has a seat but his head is free to move. The passenger of the rear trolley is not secured to his seat. Perform the experiment for slow, fast, and faster impact speeds.

Part D: Data Analysis

1. Draw a picture of the design of your rear-end collision.

2. Using a similar analysis to Parts A-C, determine what happens to both Teds.

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LABORATORY LEARNING ACTIVITY 2 – IF THE SHOE FITS

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ASELL SCHOOLS Advancing Science & Engineering through Laboratory Learning LABORATORY LEARNING ACTIVITY

If the Shoe Fits

Introduction

Many people play sport. Some are played inside, some outside. Some are played on courts, some are played on grassed ovals. Some sports need shoes with lots of friction, some want only a small amount of friction. This has led to a wide variety of shoes being developed by manufacturers to suit a range of conditions.

Shoes worn by students in the gym during an exercise at Deakin University, Melbourne Burwood Campus. Photograph © Deakin University.

We have three different types of "shoes", all of which need a person inside, hence the weights to put on top. There are:

- Spiked shoes, commonly used in athletics, and various codes of football;
- Rubber soled shoes, commonly used in jogging, basketball, netball, tennis, etc;
- Leather soled shoes, commonly used in fashion, competition dancing, etc.

We also have three different types of surfaces that these shoes might shoes might be worn on:

- Carpet "grass", used for tennis courts, hockey pitches, indoor cricket, etc.
- Sandpaper "track", which is a model for the rough surfaces on athletics tracks etc.
- Wooden "flooring", used for indoor basketball, netball, competition dancing, etc.

You will need to choose one of the "shoes" to test on the three surfaces or one of the surfaces to test the three "shoes" on.

Key ideas

Force – a push or a pull

Friction – a force that acts to stop or slow down the motion of two touching objects or surfaces as they rub against each other or slide past each other.

Materials

- spiked shoe
- rubber-soled shoe
- leather-soled shoe
- carpet "grass" lined board
- sandpaper "track" lined board
- wooden "flooring" board
- spring balances
- sandbag weights

Preliminary Planning

Shoe(s) chosen:

Surface(s) chosen:

Scientific questions

When scientists and engineers ask a scientific question, they make a prediction: ***if this thing is changed, then that is expect to happen***. In testing that prediction, they try to keep all other factors unchanged.

Suggest a couple of scientific questions that you could ask using your experimental equipment and materials:

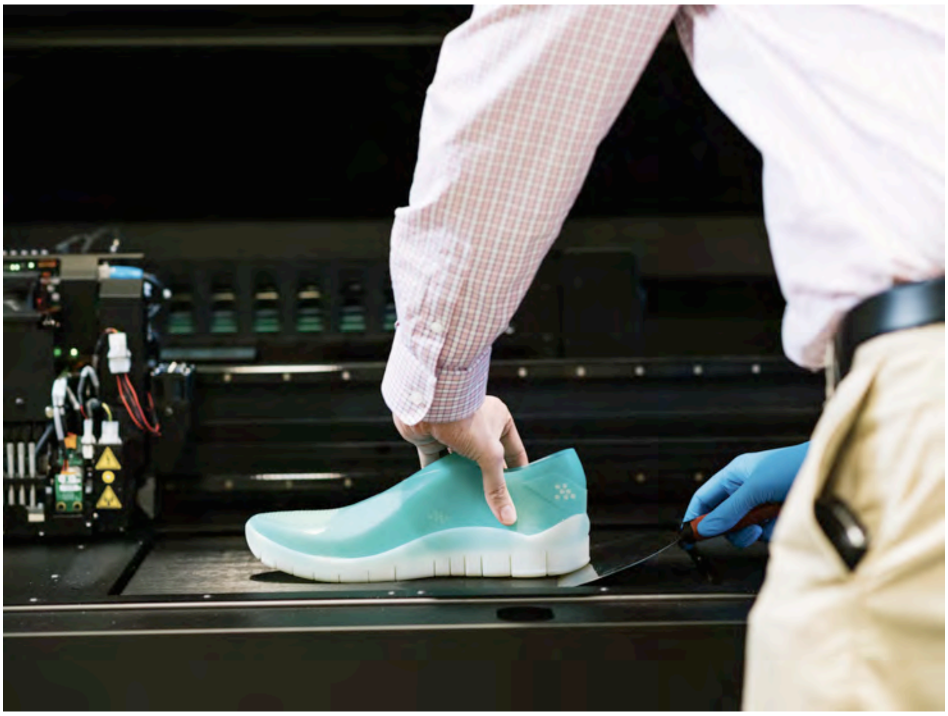
Some scientific questions will be more suitable for investigation in a classroom setting. Your teacher will lead a discussion to decide which scientific questions will be investigated. Your group will then decide how to investigate that question.

The **scientific question** that my group will investigate is:

What is the **independent variable** that you will be changing?

What is the **dependent variable** that you will be changing?

What are some of the variables that you will need to control while you do this experiment? (These are your **controlled variables**.)



The model of a shoe is perfected in research at Deakin University, Geelong Waurn Ponds Campus. Photograph © Deakin University.

Scientific report

A scientific report is a standard way of reporting what has been done in a scientific investigation. Here, you are given prompts to complete the various sections of a scientific report:

- Aim
- Hypothesis
- Method
- Results
- Discussion
- Conclusion
- List of references

Aim

You will need to write an **aim** that reflects both your independent and dependent variables. Remember the **aim** usually starts with a "To …"

To

Hypothesis

You will also need to use your independent and dependent variables to write a **hypothesis**, which usually has the format, "If the **independent variable** has <*a specific change*>, then the **dependent variable** will …".

Our hypothesis is:

Method

What **experimental method** will you need to take to test your hypothesis? Remember that this needs to be written in numbered step format and not include anything personal. If you need to repeat a number of steps, then say "repeat steps 5 to 7 with …. changed" rather than rewriting it all again. Make sure that you specifically say how you will be keeping the controlled variable consistent and what to record as results.

Results

Qualitative results are observations and information that cannot easily be measured.

Quantitative results are numerical measurements, and your analysis (plural: analyses) of those measurements. If you have quantitative results, one analysis might be to take the average of a set of repeated measurements.

You might use written text, pictures, tables and/or graphs, to record, represent and describe patterns or relationships in your observations and data.

Discussion

This section consists of what you think is the meaning of your **results**. Here you might compare **results** with predictions (in the **hypothesis**) and develop explanations for what you have observed or measured.

Conclusions

The word "**conclusions**" has two different meanings:

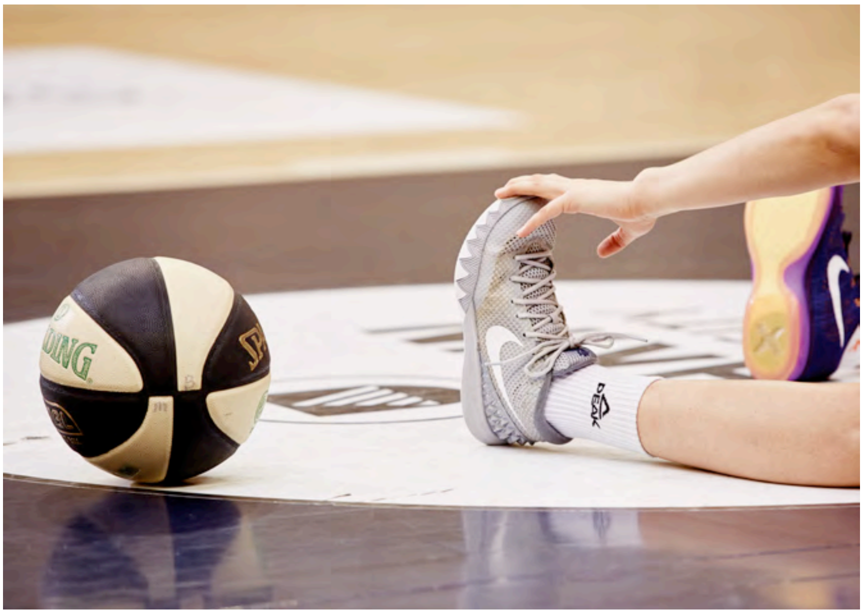
1. the **end** or **closing statement** (**summary**) of a piece of writing. This is what is intended for the **conclusion(s)** of a scientific report;

2. **judgement** or **finding(s)** reached by analyses or thinking about the **results**. Any deductions, inferences, interpretations, and judgements about the **results** should be in the **discussion** section.

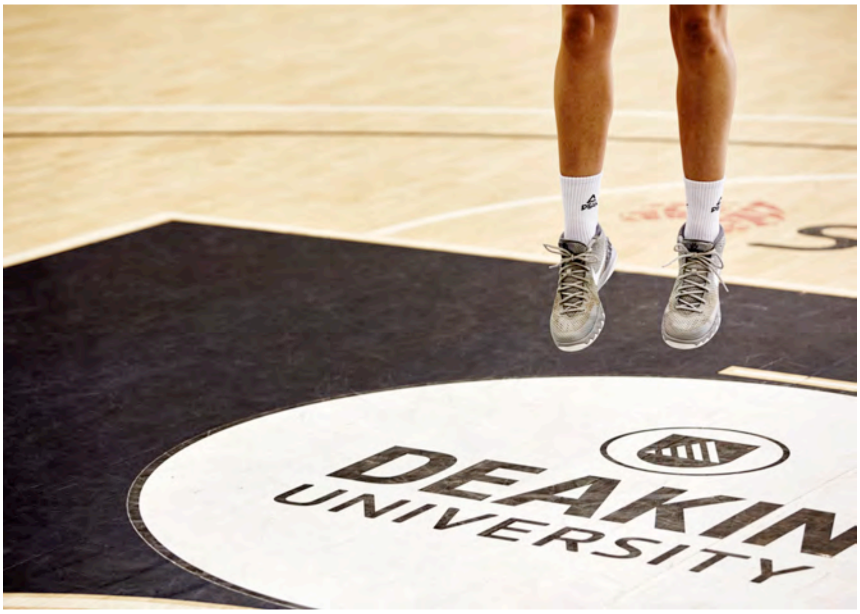
The **conclusion(s)** has (have) a very brief summary of the hypothesis, method, main results and major findings of the investigation.

References

Normally, you would list the books, websites, and other sources of information that have been used in thinking about this investigation. A list of references will not be required for this report.



Feet of Boomers players while stretching, showing specialised basketball shoes. Deakin University, Melbourne Burwood Campus. Photograph © Deakin University.



Feet of a Boomers player while shooting, showing specialised basketball shoes.
Deakin University, Melbourne Burwood Campus. Photograph © Deakin University.

Acknowledgements

The contributions of Kieran Lim and Ian Bentley, to the refinement of this laboratory learning activity are gratefully acknowledged.

- The photographs of shoes worn by Deakin University students, Deakin University shoe research, and Boomers players are used by permission of Deakin University.