All Wired Up!

Science, Level 4

The Learning Context:

In this unit students will explore electricity as they design and construct a simple electronic game or toy to exhibit at a "Toy Expo".

During the first stage of the unit students will investigate electrical energy and understand the different components that are required to make and control an electric current. They will apply problem solving strategies and cooperative skills as they work together to create a range of electronic circuits.

During the next stage of the unit students will design and make an electronic game or toy using their scientific knowledge about electronic circuits. Students may choose to make a game that uses light bulbs and/or buzzers, or they may elect to make a battery powered moving toy. Students will need to work within a timeline, make careful use of resources, and test and modify their design.

The final stage of the unit requires students to organise a "Toy Expo" where they can share their electronic games and toys with an audience. Students may choose to invite other classes, parents, and/or extended family members to their Expo.

Approximately 12 lessons

Achievement Objectives:

SCIENCE CURRICULUM:

LEVEL 3/4:

Investigating in Science: *Students will build on prior experiences, working together to share and examine their own and others' knowledge. They will ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.*

Communicating in Science: *Students will begin to use a range of scientific symbols, conventions and vocabulary. As they …*

Physical World – Physical Enquiry and physics concepts: *Explore, describe, and represent patterns and trends for everyday examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound, waves, and heat. For example, identify and describe the effect of forces (contact and non-contact) on the motion of objects; identify and describe everyday examples of sources of energy, forms of energy, and energy transformations.*

Science Learning Outcomes:

Students will be able to:

1. Construct and draw diagrams of simple circuits using the correct symbols.
2. Explain how series and parallel circuits work and how they affect the brightness of light bulbs.
3. Explain the terms "conductors" and "insulators" and give examples of each.
4. Design and build a game or toy that uses an electric circuit to work.
5. Evaluate the success, or otherwise, of their electronic game/toy.

Enterprising Attributes:

- *Generating, identifying, and assessing opportunities*
- *Generating and using creative ideas and processes*
- *Identifying, solving, and preventing problems*
- *Monitoring and evaluating*
- *Working with others and in teams*
- *Identifying, recruiting, and managing resources*
- *Planning and organising*
- *Collecting, organising, and analysing information*
- *Communicating and receiving ideas and information*

Teachers to observe and collect evidence of these enterprising attributes in action.

Resource Requirements:

- School Journal texts:
  "Super Toy Makers" (Connected, Number 1, 2005)
  "Electric Map" (Connected, Number 3, 1998)
- Text: Making Better Sense of the Physical World, Levels 1 -4, Ministry of Education
- Torches
- Wire
- 1.5 V Batteries
- Light bulbs
- Commercial and home-made switches
- Buzzers and bells
- Other materials such as pegs, foil, toothpicks, bulldog clips, fabric, etc
- Cardboard shoe boxes
- Cardboard
- Decision Making Grid

Teaching and Learning Sequence

NB: Teachers are encouraged to gauge the prior knowledge of their students before implementing each unit so that they can provide personalised and meaningful learning opportunities. The teaching and learning sequence provided in each unit is to be viewed as a guide only. Teachers will need to adapt this sequence to meet the needs of their students, school and community.

The future focus issue of enterprise can be explored during this unit. Students will need to be innovative and enterprising in all their actions to be successful at creating a new toy. They will be risk takers, creating ideas, recruiting and managing resources, carrying out the decisions, adding value to those resources, and therefore they are being entrepreneurs.

The numbered activities listed below are learning steps rather than lessons. Teachers may choose to combine two or three learning steps into one lesson. Alternatively, they may spread one learning step out over several lessons. This will be largely dependent on students' prior knowledge and their subsequent learning needs.

	LINKS TO BES Best Evidence synthesis
Getting started: The teacher reads the journal story "Super Toy Makers" (Connected, No. 1, 2005). This story describes how a class of students make battery powered moving puppets for a puppet play. The unit and focus for learning is described to the students. Explain that the class will: • explore electrical energy by making a range of electrical circuits, and • design and make an electronic game or toy to share at a "Toy Expo". The students decide who to invite to their "Toy Expo" and set a date, time and venue for the event. They also prepare a time line with the support of the teacher to record 'actions to be completed by….' Students make and distribute invitations and advertising posters for their "Toy Expo". The class creates a timeline for the unit with key dates for critical actions. This process will make the teaching sequence of the unit explicit to the students.	***2. Quality teachers facilitate active learning in the classroom.***
Exploring: 1. The teacher and students complete a brainstorm to record students' prior knowledge about electricity. Prompt questions could include: How is electrical energy made? What do we use electrical energy for? How do you make electricity flow through a circuit? How does a light bulb work? How does a switch work? What materials conduct electricity? How does a battery work? Etc. 2. Students investigate a simple circuit by exploring how a torch works (this activity is listed in "Making Better Sense of the Physical World: Levels 1-4). Students firstly draw an outline around a torch and draw inside it what they think is contained within the torch. Students then dismantle the torch carefully and lay out the parts of the torch on a flat surface. They discuss the function of each part and look closely at the bulb and switch to try and trace the flow of electricity. Students then put the torch back together and switch it on. If it does not work they try to find out why not (the most common problems are blown bulbs, loose or poor connections, or a flat battery). Students then draw a second outline of a torch and draw what they observed inside the casing. (Learning Outcome 1) Collecting, organising and analysing information Innovation, inquiry, and curiosity.	***3. Quality teachers recognise and build on students' prior knowledge.*** ***5. Quality teachers allow students to solve problems.*** ***7. Quality teachers encourage critical thinking.***

3. Students explore electrical circuits in small co-operative groups. Firstly give students the following equipment: wires, 1.5 Volt batteries (x2), 2.5 Volt light bulbs (x2) and a switch. Ask them to construct a simple circuit that uses all of the equipment. Are there different ways that the circuit can be built? The teacher draws all possible combinations on a poster using the correct scientific symbols for each part of the circuit (see pg 68 in "Making Better Sense of the Physical World: Levels 1-4). Students read the diagrams and make each circuit. (LO 1) Collecting, organising and analysing information, Working with others and in teams	***2. Quality teachers allow students to help each other.***
4. Students explore further possibilities for electrical circuits by using different equipment (introduce the use of buzzers) and different equipment combinations. Students work in small co-operative groups to investigate the following questions: • Can you make a working circuit using just one battery, one bulb/buzzer and one piece of wire? • Can you make a working circuit that uses one battery, one bulb/buzzer and two wires? • Can you make a working circuit that uses two batteries, one bulb and three wires? How many different ways can you make the bulb light up? • Using a battery, bulb and small piece of wire, make the smallest possible circuit in which the bulb lights up. • Using wires of various lengths, make the largest possible circuit in which the bulb lights up. • Use various types of switches (made from paperclips, pins, split pins, etc) in the circuit to turn the bulb or buzzer on and off. Encourage the students to draw each circuit that they make using the correct scientific symbols. (LO 1) Working with others and in teams, Generating and using creative ideas and processes	***4. Quality teachers create effective and sufficient learning opportunities.***
5. The students read the article "Electric Map" (Connected, No. 3, 1998). This article provides a diagram of an electric circuit. The students make and test the 'electric map' provided and explain how it works. (LO 1)	
6. Students explore the difference between a 'Series Circuit' and a 'Parallel Circuit'. They firstly make a 'Series Circuit' using a battery, wires and two bulbs. The circuit is wired up so that the bulbs, battery and wires make a circle. Ask students to take one bulb out of the circuit. What happens to the circuit? Why do you think that happens? Students then make a 'Parallel Circuit' using the same equipment. This time the circuit is set up as follows: a wire is attached to each end of the battery terminal; two shorter wires are twisted onto the free end of each wire so that each wire branches out in a Y shape; then a bulb in a holder is joined between each pair of wires. Once the circuit is set up take one bulb out. What happens to the other bulb? Why does it happen? (Learning Outcome 2) NB: The remaining bulb in the 'Series Circuit' should go out when the bulb is removed as the circuit is broken. The remaining bulb in the 'Parallel Circuit' should remain lit when the bulb is removed as the circuit remains closed. The two bulbs in the 'Series Circuit' should be dimmer because the electrical current has to go through one bulb and then the other. In contrast, the bulbs in the 'Parallel Circuit' are brighter because each bulb has its own circuit.	***9. Quality teachers promote sustained thoughtfulness through questioning approaches, wait time and opportunities for application and creativity.***

7. Students explore what materials allow electricity to pass through them by setting up a simple circuit using a battery, wires, 2 paperclips and a bulb. They then place different materials such as fabric, pencil lead, toothpick, foil, peg, bulldog clip, metal sharpener, etc, in between the 2 paperclips so they are touching each one. Does the light bulb glow? Students record their results on a table like the one overleaf:

Does electricity flow through the substance?	Prediction	Result
Fabric		
Plastic peg		
Pencil lead		
Toothpick		
Foil		
Bulldog clip		

Introduce the terms 'conductor' and 'insulator' to the students during this investigation. (Learning Outcome 3)

8. Students re-read the story "Super Toy Makers" (Connected, No. 1, 2005) and discuss how the students in this story make the moving puppets. What equipment do they use? How do they wire the toy up? Are all the puppets made in the same way? Students then work in small co-operative groups to try and produce their own moving toy. Students share their creations with their classmates. (Learning Outcome 1)

Planning and Creating:

9. Students are encouraged to bring electronic games and toys from home to share with the class. The students view each game/toy and play with it. They then discuss how each game/toy is constructed and how the electrical energy is used. (Learning Outcomes 1 and 4)

10. The teacher and students brainstorm a list of games and toys that could be made using electrical energy. The list could include the following ideas: a doll's house with working lights; a clown with flashing eyes; a steady hand game that requires you to pass a metal loop over a twisted wire pathway; a question and answer game that lights up when you match the correct answer to the question; a puppet with movable arms and legs; etc. Students need to describe what kind of electric circuit they would need to construct for each option. (LOs 1 and 4) Generating, identifying and assessing opportunities

11. The students decide what kind of game or toy they would like to make. They may choose to use a Decision Making Grid to help them select their option. Possible criteria for the Decision Making Grid could include: What equipment will I need? Will I be able to source the equipment? Do I have the time to complete it by Expo? How much money will the equipment cost? How easy will the game/toy be to make? Will the game/toy appeal to my intended audience? Etc. (Learning Outcome 4) Generating, identifying and assessing opportunities

12. The teacher and students create a set of "success criteria" to measure their completed games or toys against. Possible criteria could include: the game/toy works well; the game/toy is durable; the game/toy is popular with other students; the game/toy demonstrates good knowledge of electrical circuits; the game/toy is original; the game/toy is safe. Etc. (LO 4) Excellence

10. Quality teachers involve students in the process of setting specific learning goals.

13. The students spend the next series of lessons planning and making their electronic games/toys. Students may choose to work independently or in small groups. To encourage students to be careful with the resources the teacher may choose to limit the equipment available to students (eg: 1 metre of wire, 2 light bulbs, 2 batteries, etc) or students could 'buy' the equipment using tokens with each item having a set 'token price'. The students will need to sketch a game/toy design and describe what steps they need to take to make their product. They will also need to construct a timeline which outlines their intended progress and lists people's responsibilities if the game/toy is being made by a group. (LO 4) Planning and organising, Identifying, recruiting and managing resources, Monitoring and evaluating 14. Students share their games/toys with each other and evaluate their progress using the "success criteria" drawn up at step 12. Students modify their games/toys if necessary. (LO 4) Communicating and receiving ideas and information, Monitoring and evaluating, Identifying, solving and preventing problems Excellence	***10. Quality teachers utilise assessment to improve learning.***
Sharing and Evaluating: 15. The teacher and students organise and host their "Toy Expo". Students set up their games/toys at the venue and are given responsibilities to assist in the smooth running of the Expo. Responsibilities could include: welcoming committee, tour guides, security officers, spokespeople who explain the learning, etc. 16. Students use the "success criteria" that they drew up at step 12 to evaluate their games/toys. Students also ask for feedback about their games/toys from their class-mates and visitors to the "Toy Expo". Monitoring and evaluating 17. Students then identify the strengths of their game/toy and areas for improvement. (Learning Outcome 5) Monitoring and evaluating 18. Students re-visit the brainstorm written up at step 1 of the unit and add their new knowledge about electrical energy in a different coloured pen. This process will enable students to see the learning that has taken place. **Reflective Questions:** Exploring new knowledge and skills • What is electricity? • How is electricity made and controlled? • What equipment do you need to make a light-bulb glow? How do you set the equipment up to make the light bulb work? • Can you draw this circuit in a diagram using the appropriate scientific symbols? • What is the difference between a 'Series Circuit' and a 'Parallel Circuit'? • What is a conductor? • What is an insulator? • How important is electricity in our daily lives? • Was I pleased with the game/toy that I made? • What did visitors and my classmates think of my game/toy? • What game/toy was popular and why? • Would I do anything differently if I was able to make my game/toy again?	***10. Quality teachers use evaluations that are purposeful and supportive of the learner.***

Exploring what it is to be innovative and enterprising

- What step/s were you doing when you used each of the enterprising attributes? Break each attribute into its separate words and refine your answers.
- How could you improve on using the enterprising attribute/s for next time?
- Can you transfer this learning to your other topics?

Exploring further future focus issue

- Whose toy do you think had the most creative ideas included in it? Explain why you believed this to be 'creative'.
- Do you think the toys demonstrated that students had been innovative and enterprising? Why?
- What is the consequence of enterprise?
- Are there any toys that would sell in the market place? Why or why not?
- What values did you need to apply in this learning? Did they help you to become more successful?

Possible Assessment Activities (Teacher):

Suggested assessment resources are listed below. These resources assess key knowledge about electricity and they are linked to the Physical World strand.

Assessment Resource Bank Resources – Level 4:

PW 4522	PW 4504	PW 4094	PW 4062	PW 3656	PW 3654
PW 3653	PW 3647	PW 3643	PW 3681	PW 3678	PW 3637
PW 3634	PW 3628	PW 3620	PW 3532	PW 3692	PW 3682

Level 3 Science Exemplar:
Zap It! A Toastie Explanation

Decision Grid

Choices / Criteria					
Total					