Gifted and Talented Education

Science and Technology

Stage 1

Toy World unit

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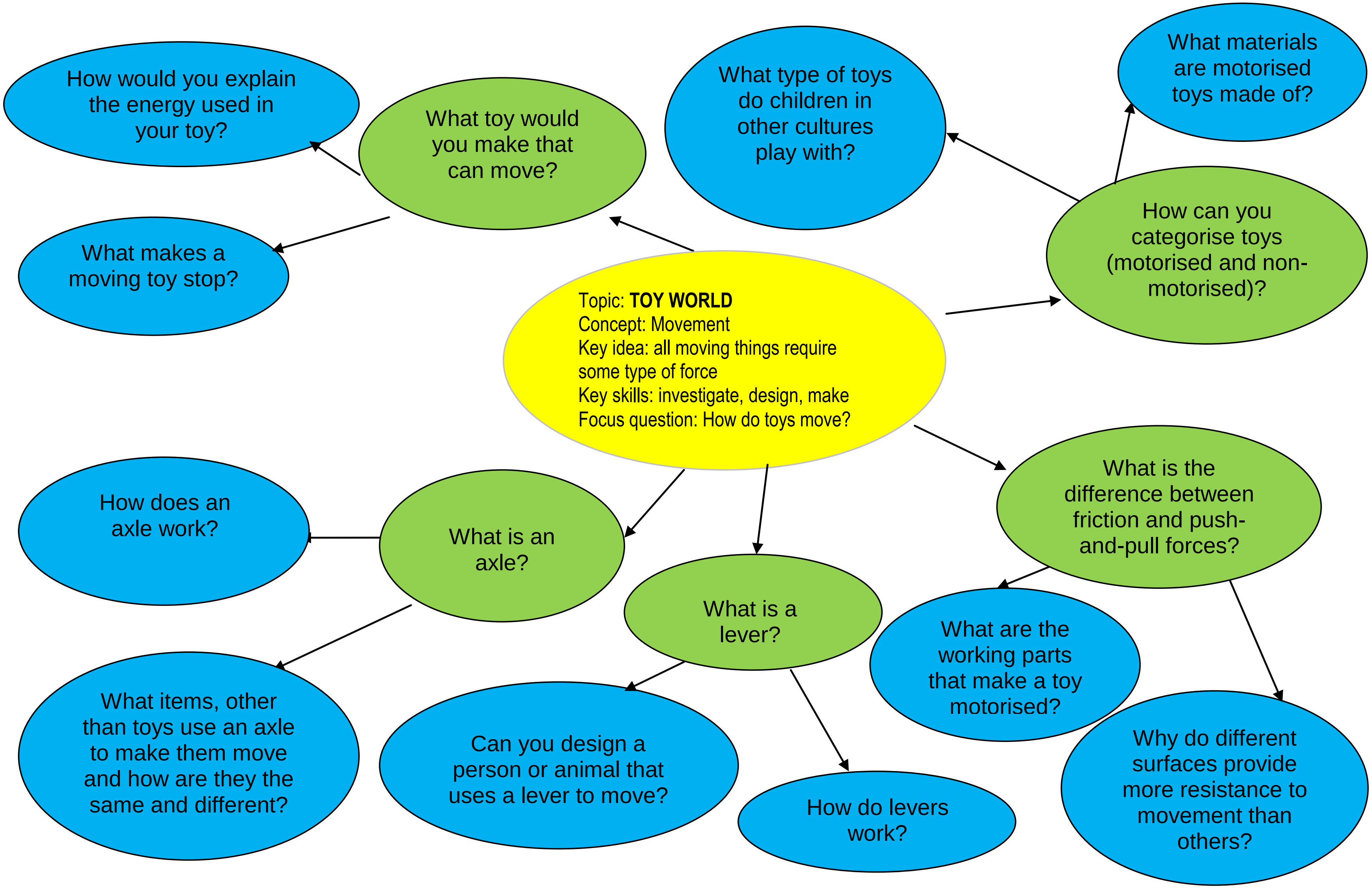
Topic: **TOY WORLD**
Concept: Movement
Key idea: all moving things require some type of force
Key skills: investigate, design, make
Focus question: How do toys move?
What toy would you make that can move?
How would you explain the energy used in your toy?
What makes a moving toy stop?
How can you categorise toys (motorised and non-motorised)?
What type of toys do children in other cultures play with?
What materials are motorised toys made of?
What is the difference between friction and push-and-pull forces?
What are the working parts that make a toy motorised?
Why do different surfaces provide more resistance to movement than others?
What is a lever?
Can you design a person or animal that uses a lever to move?
How do levers work?
What is an axle?
How does an axle work?
What items, other than toys use an axle to make them move and how are they the same and different?

Toy World unit overview

This unit of work has been designed for Year 2 with a small number (3-5) of gifted and talented students. It is based on the *Science and Technology* Stage 1 unit 'Toy World' (*Science and Technology K-6 Syllabus and Support Document* pp. 72-73).

The areas for extension are based on Bloom's taxonomy (1956) of higher-order thinking and provide more challenging tasks for students who already know the basic content. The Maker model (1982) was chosen to modify the unit, as its use can produce 'substantial' gains for students in the academic, social and emotional domains of development. Using the Maker model the unit has been modified as shown below in content, process and product. The learning environment is a positive and student-centered workplace.

Content modifications	
Abstraction	What is a toy? What kinds of toys are there?
Complexity	Identify ways that toys can move?
Variety	What is a push, pull? Friction? Pneumatics? Hydraulics?
Organisation	Draw a Venn diagram.
Study of people	Interview or research a person who makes or repairs toys.
Process modifications	
Higher-order thinking skills	Can you modify the toy so that it moves faster? Goes up a hill? Carries a one kilogram load?
Open-ended processing	Invent a toy that will meet a specific need.
Proof & reasoning	Investigate other designs and do a PMI on your design and one other.
Group interactions of like-ability peers	Can you find a way to improve the design?
Product modifications	
Real-world problems	Pull apart a broken toy and find out why it no longer works. Can it be repaired or fixed?
Real audiences	Write to a toy manufacturer and give reasons why they should buy your invention.
Evaluations	Ask students in different grades to evaluate the toy using pre-established criteria.
Learning environment: • is flexible and open • encourages independent and intrinsic learning • is accepting and non-judgemental • encourages complex and abstract thought • is student-centered.	

Mathematics	Investigating properties of 3D objects
English	Procedures, joint construction, label models/sketches, talking to audience
PDHPE	Movement exploration (body, equipment)
HSIE	Individual and cultural differences
Creative Arts	Sketches, sequence based on direct experience

Further thinking to extend assessment and rich learning environment:

1. Students present their toy creations to “parent buyers’ at a **Toy Expo** open morning.

2. **Classroom museum of toys across cultures** of interesting toys that children have brought in from home and put on display (e.g. Aboriginal string games; Chinese checkers, Malaysian kite flying, Indian bead game, etc.)

Positive effects on learning outcomes are achieved when all elements of the NSW *Quality Teaching* (2003) model are addressed. This was used as a framework and all elements have been considered in preparing the unit of work.

Intellectual quality	
deep knowledge	The starting place is students' prior knowledge and the focus is sustained on key ideas and concepts.
deep understanding	Regular assessment of understanding is incorporated in the unit.
problematic knowledge	Students are encouraged to consider multiple solutions.
higher-order thinking	Bloom's taxonomy is used to create higher-order questions and tasks.
metalanguage	Clarification of meanings and definitions with students throughout lessons
substantive communication	Students generate questions about the topic which is used for lesson development.
Quality learning environment	
explicit quality criteria	Detailed criteria regarding the quality of the work is made explicit and reinforced throughout the unit of work.
engagement	Learning is meaningful and interesting to students.
high expectations	Children are encouraged to try hard and take risks in challenging work
social support	There is strong positive support for learning and mutual respect.
students' self-regulation	Activities are purposeful and interesting with clear goals. Students demonstrate autonomy and initiative.
student direction	Activities are tiered so that students determine what challenges they meet.
Significance	
background knowledge	Students are pre-tested to identify prior knowledge.
cultural knowledge	There is valuing and acceptance of the beliefs and skills of all social groups.
knowledge integration	Meaningful connections are made using problems where students can strengthen the learning of key concepts.
inclusivity	All students' contributions are taken seriously and valued.
connectedness	The students can connect what is being learned to situations outside the classroom.
narrative	Narrative is used to enhance the significance of the lessons.

Curriculum Differentiation

The needs of gifted and talented students

The needs of gifted and talented students can be met by a differentiated curriculum. Differentiation ranges from slight to major modifications of the curriculum through adjustments to content, processes and skills. It provides a planned, documented and challenging curriculum that matches the ability of gifted students to:

- learn at faster rates
- find, solve and act on problems more readily
- manipulate abstract ideas and make connections to an advanced degree.

(NSW Department of Education and Training, 2004)

The curriculum differentiation process

The following steps were followed to develop a differentiated unit of work.

- Decide on the syllabus outcomes to be assessed.
- Define the key concept(s) that underpin the unit.
- Devise focus and contributing questions. The contributing questions should relate to the assessable outcomes and illustrate what questions students will have answered on completion of the unit. The contributing questions guide the development of the pre-assessment.
- Write one structured/support question and two extended questions for each contributing question where appropriate. Some students will not be able to complete the core content and will need scaffolding support to complete the unit. Extension questions on the other hand are designed to provide challenging work for those students who can work beyond the core curriculum.
- Design pre-tests or pre-assessments (graphic organiser, flow chart, concept map, discussion questions). Students who qualify for extension work can be identified through pre-testing or pre-assessment.
- Develop support and extended outcomes to correlate with support and extended questions.
- Construct the activities for support, core and extension.
- Write assessment tasks, formulate criteria and determine date of assessment.
- Develop and conduct formative and summative evaluation.

This approach to differentiation allows for three levels of student readiness. Students who are achieving at stage level will be appropriately challenged by finding answers to the core-level questions. However, some students will not be ready to work at stage level and will need teacher support and learning activities to assist them to achieve stage outcomes. Extension questions and activities need to be developed for those students who have demonstrated achievement of outcomes at stage level through pre-assessment or pre-testing.

Concept mapping

Ideas for possible extensions to the ***Toy World*** unit are illustrated in the concept map on page three. It shows the core curriculum focus areas in the green boxes and the suggested extension questions are shown in the blue boxes. Students who have achieved the outcomes specified are eligible for extension. They qualify after pre-testing or pre-assessment on their knowledge of the content knowledge and their understanding of the SciTech *Design and Make* process.

Using the models of curriculum differentiation

There are numerous models of curriculum differentiation that can be applied creatively to produce programs that provide flexibility and choice, for the range of individual differences in the classroom. These models show how content, teaching and learning processes and products can be fine-tuned to meet the needs of gifted students. This unit of work has been designed using the Maker model.

The Maker Model

In this unit the Maker model (1982) has been used to develop ideas for extension activities. This model shows how content can be adjusted to accommodate the ability of gifted students to manipulate abstract ideas and deal with complexity. The process component of the model involves the methods that are used by teachers to present information, the questions asked of students and the mental and physical activities expected of them. This dimension of curriculum design is focused on higher-level thinking, creative problem solving, decision-making, planning and forecasting.

Maker (1982) also emphasises the importance of allowing students to create products that solve real-world problems and for the opportunity to present work to a variety of audiences for authentic feedback. Information on the Maker model (1982) can be found in the NSW Department of Education and Training's *Curriculum Differentiation* support package available at:

http://www.curriculumsupport.education.nsw.gov.au/policies/gats/support/index.htm

Science and Technology Stage 1

The Syllabus document used to inform this unit of work was the *Science and Technology K-6 Syllabus and Support Document* pp. 72-73.

Foundation Statement

Students follow a guided design process to create products. They draw and model design ideas using accepted methods and practices.

Core Outcomes

Content Strands		
Physical Phenomena	PP S1.4	Identifies and describes different ways some forms of energy are used in the community.
Products and Services	PS S1.5	Grows, makes or processes some products using a range of techniques and materials.
Learning Outcomes		
Investigating	INV S1.7	Conducts guided investigations by observing questioning, predicting, collecting and recording data, and suggesting possible explanations.
Designing and Making	DM S1.8	Develops and implements own design ideas in response to an investigation of needs and wants.
Using Technology	UT S1.9	Selects and uses a range of equipment, computer-based technology, materials and other resources to undertake an investigation or design task.
Values and Attitudes		
	VA1	Demonstrates confidence in their own ability and a willingness to make and implement decisions when investigating designing, making and using technology.
	VA2	Exhibits curiosity and responsiveness to scientific and technological ideas and evidence.
	VA3	Initiates scientific and technological tasks and challenges and perseveres with them to their completion.
	VA4	Gains satisfaction from their efforts to investigate, to design, to make, and to use technology.
	VA5	Works cooperatively with others in groups on scientific and technological tasks and challenges.
Extended Outcomes		
Investigating	INV S1.7	Classifies toys according to set criteria.
Designing and Making	DM S1.8	Evaluates toys in terms of meeting the design criteria.
Using Technology	UT S1.9	Justifies choice of materials used.

Content	Skills	Knowledge
Basic Abstract	Explore Investigate	Energy, force, push, pull, lever, axle, spring.
Complex Abstract	Evaluate Analyse	Friction, centripetal force, cogs, pivots, hinges, shafts, ball bearings.

Contributing questions

- How can toys be classified?
- What is a push/pull?
- Where does the energy to make toys move come from?
- How do levers and axles work?

Extended questions

- What moving parts are in toys?
- How does friction affect movement?
- How do pivot points affect the movement of objects?

Evidence of learning

Core task

- students will demonstrate their understanding by producing a toy that moves.

Extended task

- students will develop a more complex moving toy that uses more than one simple machine (lever, axle).

Criteria for learning

Core task

Students will be assessed on:

- the design plan for a moving toy
- the final product (by teachers and students in terms of movement, interest and appearance)
- self-assessment
- on-going observation and questioning.

Extended task

- explain the workings of the toy
- analyse the materials used
- justify the use of the forces chosen to move the toy
- judge the finished product according to a set criteria.

Stage 1 Toy World unit pre-test

Name: ________________________

1. What are toys? ____

2. Why do children use them? ____

   ____

3. How can toys move? ____

   ____

4. What do you understand by the terms push and pull? ____________________

   ____

5. Draw your favourite toy and label the parts.

Teaching and learning sequence

The teaching strategies selected to support teacher implementation of this unit include the following strategies as in the *Science and Technology K-6 Syllabus (p.142)* and are listed beside each task below.

Teaching strategies

TS6	*Fostering curiosity*
TS7	*Observing to explore and discover*
TS8	*Researching to explore and discover*
TS12	*Clarifying an investigation*
TS15	*Explaining understandings*
TS18	*Clarifying a design task*

Task 1: Investigate toys (focus: ***6, 7***)

- Use a large collection of toys brought in by the students. Distribute among small groups.
- Classify according to things they have in common, e.g. board games, balls, indoor/outdoor.
- Identify characteristics, likes/dislikes, advantages/disadvantages.
- Identify toys and games that can be made from naturally occurring materials, e.g. sticks, stones, string.
- Explore their uses, e.g. throwing, kicking counting, etc.
- Relate their properties to their use, e.g. rolling, bouncing, stretching, soft, hard, etc.

Extended

- Using a Venn diagram, classify the toys according to their similarities and differences.
- Pull apart old toys and analyse their moving parts.

Task 2: Investigate how toys can be made to move (focus: ***6, 7, 8, 15, 18***)

- Gather a variety of toys that move and use them to explore the concepts of fast/slow, still/moving.
- Explore their uses. Relate their properties to their use, e.g. rolling, stretching, bouncing.
- Classify toys according to the way they move, e.g. roll, spin, slide, bounce, fly.
- Identify the parts that move.
- Explore the effect of a push/pull on a toy. Predict how it can be made to go faster and slower. Test predictions by applying different forces.
- Identify objects that rely on forces to be moved, e.g. skateboards, bikes, prams, pogo sticks, kites, yoyos, spinning tops.

Extended

- What happens to the distance a truck travels as the load is increased?
- Investigate what happens to a truck when it is on a slope. Increase the angle of the slope. What happens to the speed (distance travelled) of the truck as the slope increases? What happens to the distance travelled as the slope gets steeper?
- Are the trucks the same size? Mass?
- Hypothesise how slope affects distance travelled.

- How does moving on different surfaces affect the distance travelled? Try different surfaces such as lino, carpet, asphalt, aluminum foil, fabric, etc.
- How does friction affect acceleration and deceleration?
- Which surfaces provide more friction?

Task 3: Find out about axles and levers (focus: ***6, 7, 8, 15, 18***)

- Using a range of toy cars discover which parts move. Which parts spin? How do the parts that spin stay attached to the car?
- Using screwdrivers pull the cars apart. How are the moving parts attached to the car? Draw and label these parts.
- Design and make a model car using saté sticks, wheels, Lego, milk cartons, etc. Which car is fastest? How well does it roll?

Extended

- Students investigate a jumping jack. How are the arms and legs attached? What happens when the string is pulled? Which parts move? How are the arms and legs joined to the body? What happens when the string is pulled? How do the moving parts move?
- Design a person or animal using levers. Investigate the best position for the fixed points and pivots.

Task 4: Design and make a toy that moves (focus: ***12,15, 18***)

- Using other toys as models, generate ideas for a toy. Consider if it will be used indoors or outdoors.
- Develop a design plan to make a moving toy. Consider how the toy can be made to move, its appearance and the materials needed to make it. Make a sketch and label it. Explain the model to others. What is it? What is it made from? What does it do? Can others suggest any improvements?
- Select materials to make the toy. Demonstrate how the toy works. Discuss possible improvements. Modify the toy if needed.
- Evaluate in terms of:
    - Movement: does the toy move in the way it was intended?
    - Interest: are there any features of the design of particular interest?
    - Appearance: is the toy finished off and does it look attractive?

Extended

- Design and make a toy that uses at least two different forces to make it move.
- Complete a PMI chart on the design.
- Can you alter the design to improve it?
- Evaluate using the method above.

Resources for Toy World unit

- Science and Technology Syllabus P72-73
- Outcomes and Indicators Document (2000)
- Science and Technology by Design 1 – Colin Webb
- Moving Things: Toys – Jenny Feely & Johanna Scott

Materials & equipment

- variety of toys
- Cardboard
- String
- Split pins
- Cardboard boxes
- Egg cartons
- Cotton reels
- Iceblock sticks
- Rubber bands
- Polystyrene
- Pipe-cleaners
- Scissors
- Glue
- Paint
- Screwdrivers

Word bank glossary

advantages	fast	motor	size
appearance	flying	motorised	slide
bouncing	hard	moving	sliding
brittle	identify	movement	slow
colour	improvement	non-motorised	soft
contrast	interest	prediction	spin
demonstrate	jumping	prototype	still
disadvantages	kicking	roll	stretching
discuss	long	rolling	test
equipment	material	shape	throwing

Evaluations

What is the difference between a toy and a game?

	Product
1. Teacher observation of Task 1 investigations	Venn diagram
2. Teacher questioning	Verbal contribution
3. Student sketches of axles and levers Student product	Draw a label Human Jumping Jack

References

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Resources

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Reflection

Although initially challenging, I found planning the unit a little overwhelming. It was a very structured process, but working through the steps systematically allowed me to ensure that I had differentiated the curriculum to suit the needs of all learners. This unit of work can also be adjusted as required by students' learning needs. The concept map is a great starting place as it clearly shows the focus of the unit, the key ideas and concepts, as well as showing the connections among the ideas.

The pre-test is short and designed to help with planning the unit of work rather than to assess and report on the students. By pre-testing students and using the Maker model (1982), the curriculum was modified and compacted so that students have the opportunity to achieve outcomes of a higher order. The processes of problem solving, decision making, planning and higher-level thinking are particularly relevant to the learning activities of investigating, design and make in the *Science and Technology K-6 Syllabus*.

I look forward to using this model again in other KLAs and imagine that it will become quicker and easier the more familiar I become with it.