STEM into STEAM

12

Learning Objectives
- to understand the relationship between science and art;
- to differentiate between STEM and STEAM;
- to develop an appreciation of the connections between the creative arts and STEM; and
- to better understand the needs of twenty-first-century learning, which include the 4Cs.

I know that the most joy in my life came to me from my violin. (Albert Einstein)

1 Introduction

Since it was first introduced in 2001, the acronym science, technology, engineering and mathematics (STEM) has become the buzzword in educational contexts world-wide. But if we want our students to be well prepared to negotiate the complexities of an uncertain future, then we must ensure that the education we offer is as broad and comprehensive as possible. With the current focus on high-stakes testing which often requires memorisation not understanding, students are being taught that there is a right and wrong answer. Yet the world is not black and white. Therefore 'we must encourage the youth of tomorrow to seek out multiple solutions to complex problems and the addition of the Arts with the STEM fields can combat this issue [since] well-rounded arts problems never have one answer' (Land 2013, p. 549).

As the premise of this book is to place the Arts at the centre of the curriculum, it probably comes as little surprise that we weigh in on adding the 'A' to STEM to

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create a richer, more comprehensive approach to learning. To achieve this, we offer relevant and practical activities throughout this chapter in an attempt to encourage teachers and students to draw STEM subjects and the Arts closer together.

2 Science and the Arts

Up until the nineteenth century, the sciences and the Arts were deeply entwined. It was only during the first quarter of the twentieth century that a division between the two emerged. In fact, the concepts of science and art became so estranged that they seemed to occupy different cultural worlds, even though in the previous century the terms 'had been so close that they were often used interchangeably' (Schatzberg 2012, p. 555). It was during this time that a new concept of fine art began to reshape Enlightenment ideas about art and its relationship to science.

Eisner (2002) describes the elevation of science above the Arts:

> Science was considered dependable, the artistic process was not. Science was cognitive, the arts were emotional. Science was teachable, the arts required talent. Science was testable, the arts were matters of preference. Science was useful and the arts were ornamental. (p. 2)

Over the past decade, there has been a push in the United States, the United Kingdom, Australia and a number of Asian countries to broaden and diversify the science offered in schools, to link it to technology, engineering and mathematics. In other words, the concept of STEM. Despite the widely acknowledged benefits of interdisciplinary approaches to learning, it seems that STEM is not an integrated reality in many schools. The focus often remains on science and mathematics, with engineering and technology left out of the STEM equation. Recently, researchers have argued that art and science, both dedicated to truth and beauty, are better together than apart.

3 Putting the 'A' into Science, Technology, Engineering and Mathematics

Art seems to be as old as human existence dating back 40,000 years or more. Science, as we know it, is perhaps a little more difficult to date although calculations for the Earth's movement around its axis are known from Mesopotamian and Babylonian times, that is, 35,000 years BC (Steele 2000). There is no requirement for the Arts, in order for science to exist or proceed (Braund and Reiss 2019). There are, however, numerous ways in which the Arts and the sciences do and should co-exist interdependently.

The idea of integrating the Arts with learning in other disciplines is not new and is a focus of this book. But adding the 'A' into the STEM equation may be a mechanism to re-frame a misleading curriculum concept and provide opportunities for the self-expression and personal connection that our students desire (Land 2013). According to Immerman (2011):

> As the economic activity of … the world continues to rapidly transform, the need to invest in education that promotes innovation and creativity has become primary to the central themes into this ongoing public dialogue. (n.p)

The STEM subjects alone will not lead to the kinds of innovation the twenty-first century demands. 'Innovation happens when convergent thinkers, who march straight ahead toward their goal, combine forces with divergent thinkers who professionally wander, who are comfortable being uncomfortable, and who look for what is real'(Maeda 2011, p. 34).

Scientists, mathematicians and engineers may discover some solutions to the world's problems and as a result create innovative products that may bolster the economy, but it is the artists who ask the deep questions that may reveal which direction we should take to actually move forward. Progress will not come from technology alone but from a blending of technology and creative thinking through artistic practices. Many are now seeing an obvious connection between the Arts and the STEM fields. A 2008 study by Robert Root-Burnstein found that Nobel laureates in the sciences were 22 times more likely than scientists in general to be involved in the performing arts. Albert Einstein, for example, was an accomplished violinist (see the quote at beginning of this chapter) while Leonardo de Vinci was a painter and a sculptor but also became famous as an inventor, scientist and engineer.

The Arts are an essential part of education and by adding the A into STEM, teachers may be persuaded to find meaningful ways to incorporate STEM concepts (NCES 2009; Piro 2012; Tarnoff 2010) into the curriculum. 'STEAM may actually help educators to build the foundation of science-related knowledge, using the Arts to encourage children to express their ideas in a wide variety of creative ways' (p. 36). Integrating the Arts into these content areas not only helps students to explore an idea from different vantage points but it also encompasses different types of learning—visual, auditory and kinaesthetic—thus leading to the criticality and creativity of mind that tomorrow's citizens require. If creativity, collaboration, communication and critical thinking (see 4Cs in Chap. 3)—all touted as critical skills for twenty-first-century success (NEA 2013)—are to be fostered, we need to ensure that STEM subjects are drawn closer to the Arts.

▶ **Activity**
Complete a personal reflection

- *How confident do you feel about teaching STEAM with your students?*
- *Are there specific strands of science that you feel more confident about, that is, biology, physics, chemistry, earth and space and so on.*
- *What strategies could you use to integrate STEAM into your programme?*

4 Draw a … Scientist or Artist

Almost 40 years ago, David Wade Chambers, an educational researcher decided to investigate children's perceptions of the scientist. The Draw-a-Scientist-Test (DAST) was used to learn at what age well-known stereotypical images of the scientist first appeared. Children's drawings were analysed for seven standard indicators: white laboratory coat, eyeglasses, facial hair, symbols of research, symbols of knowledge, products of knowledge (i.e. technology) and relevant captions. By examining, analysing and evaluating children's conceptual images of scientists, Chambers and colleagues concluded that students hold stereotypical images from a very early age. These perceptions influence subject and career choices and are difficult to change (Image 12.1).

Since its publication, several different scientific disciplines have been studied simply by changing the prompt from 'Draw a scientist' to 'Draw a ….'. These have included mathematician, doctor, engineer, physicist chemist, psychologist and archaeologist (Flick 1990; Schibeci and Sorensen 1983; Picker and Berry 2001).

Given that previous studies have focused on STEM careers, we thought that it might be insightful to move DAST to DAAT or Draw an artist. Here is one of the resulting drawings (Image 12.2).

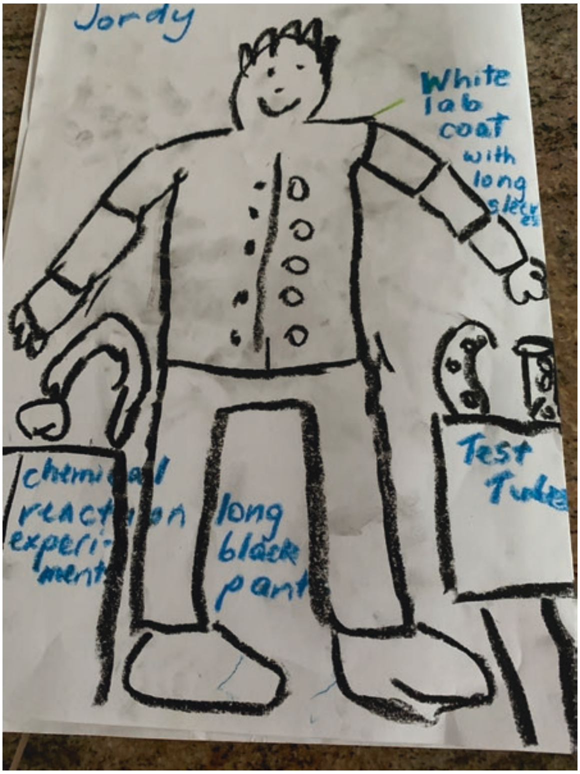

Image 12.1 Jordy's scientist

Image 12.2
Timothy's artist

5 Visual Arts and Mathematics

Many well-known artists have drawn on their understanding of the aesthetic in mathematical conventions (consider, e.g. the Golden Ratio, the Fibonacci sequence, Fractals) for inspiration for their artwork. These artists and their artworks can be a very useful starting point for studying space and shape. Several examples are provided below.

Tessellations

In helping pre-service teachers appreciate spatial patterns, Aldridge and Gibson (2002) first showed an excerpt from the film, *The labyrinth* (1986) concentrating on the 'stair sequence' that is featured towards the end and challenges, even confuses, notions of 'top/bottom' and 'up/down'. They then explored the work of M. C. Escher including *The house of stairs* (1938) and *Reptiles* (1943) and discussed the artist's use of shape and space. The students developed a word back of specific mathematical and art vocabulary (Image 12.3).

The students then worked in trios to select a shape, remove a small section (a 'nibble') to slide and attach to another side of the shape. The activity highlighted the action performed on the shape to transform it. The transformed shape formed a template, which each individual then used to create their own tessellations (Image 12.4).

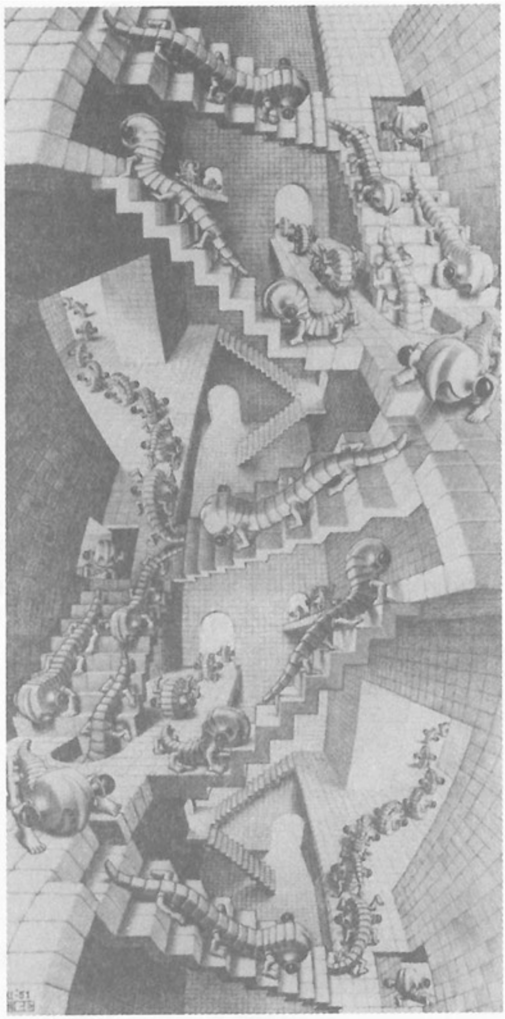

Image 12.3 *House of stairs* by M. C. Escher

In developing their tessellations the students selected a colour scheme (e.g. monochromatic, warm/cool colours, etc). They cut 9–12 shapes from coloured paper and magazine photos of similar colour scheme and experimented with flipping, sliding and rotating their shapes to eventually create their own tessellating pattern.

Shapes and Patterns

There are many real connections between the shapes and symbols used to communicate ideas in everyday life, and the teaching of shape in the classroom. A unit on shapes can be initiated by giving children digital or conventional cameras and

Image 12.4 Examples of tessellation

asking them to photograph as many examples of shapes in the playground, at home, on a bushwalk and so on. These photographs can be shared and compared with the geometric models in the classroom. Students can be asked to use a variety of materials to create a collage using as many shapes as they can (Image 12.5).

A British Office for Standards in Education, Children's Services and Skills (OFSTED) report, *Learning: Creative approaches that raise standards* (2010), documents examples from inspections of 44 English schools that have developed integrated innovative approaches to learning. One example was from a Year 1 mathematics unit on shapes and patterns. The unit began with a study of Bridget Riley's paintings (see, e.g. *Shadow play,* 1990, represented below). Children

Image 12.5 Shapes and patterns

discussed the style and impact of her work and then music was played to allow them time to think. The teacher probed their responses before dividing them into pairs to analyse another of Riley's artwork. The teacher encouraged the students to identify mathematical shapes and make judgements about the impact of the different patterns. Further discussions as a whole group enabled rich vocabulary to be built (e.g. 'zigzag', 'chequered' and helped the students better understand mathematical language such as 'semi-circle'. Finally, the students created their own Riley-inspired artwork. Several used computers to arrange a set of shapes into as many patterns as they could find. They applied the same kind of evaluation to their own creations as they had to Riley's (Image 12.6).

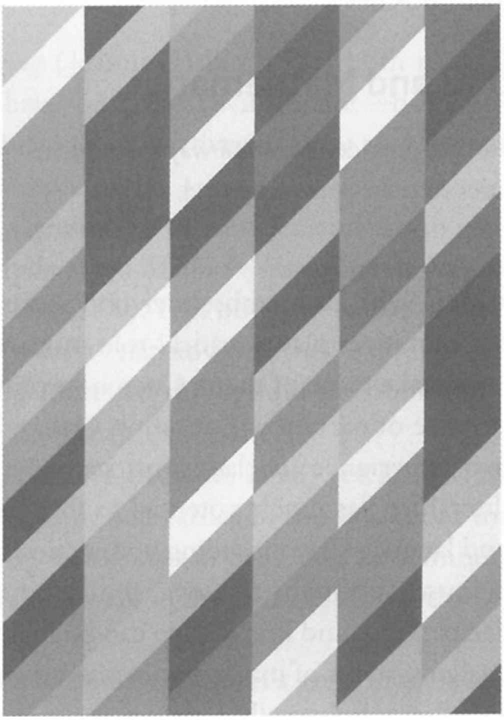

Image 12.6 *Shadow Play*, 1990, Bridget Riley

Science and Embodiment

In light of students waning engagement in science, Carole Haeusler from the University of Southern Queensland believes this lack of interest is, in part, related to poor pedagogy. She has been undertaking research that challenges the assumption that atomic molecular theory is too difficult for primary children to understand. Her research explores new ways of introducing atomic theory including embodiment of the processes to students in Year 4 in Brisbane, Australia. Pre-intervention interviews and drawings explored the children's attitude to and knowledge about atoms and molecules. They articulated children's real interest in learning about scientific concepts and marked curiosity to know more. Experiential activities were used to introduce the relevant concepts. For example, the relative size of atoms was explored by the children through exploring the weight of different metals and nonmetals and ordering them in sequence. Electrical charge was introduced through enacting repulsion and attraction. Post-intervention interviews documented evidence that almost all of the participating students demonstrated genuine understanding of matter as particulate eight weeks after the intervention. A smaller but significant percentage were able to represent more details about atoms. For more information, see Haeusler and Donovan (2017). Further work on embodiment and science is continuing.

Example

Probability, Visual Arts and Design

This unit is designed for Stages 3 and 4 to explore probability theory adapted from one developed by the Mathematics Faculty, Sir Joseph Banks High School.

Students were given a rich task, incorporating exploring mathematics, design and visual arts. They were 'en-roled' as designers for a creative games company that produces board games for 6–9-year-olds. Their manager gave them the assignment of designing a spinner using materials of their choice (e.g. wood, metal, heavy cardboard) for a new board game with the following criteria. The assessment was then negotiated.

The spinner must:

- be attractive for a child aged between seven and nine;
- use five colours;
- be designed so that the probability of blue is twice that of green, red three times that of green, yellow twice that of blue and black three times that of red; and
- be functional. ◄

6 STEAM and Stories

Teachers often use fiction as a stimulus for supporting learning across the curriculum. Quality texts can easily be used to provide a starting point for a STEAM investigation. Picture books such as *The hungry caterpillar* by Eric Carle and *The enormous turnip* by Alexi Tolstoy are obvious examples in the early years of school.

Claire Hewett (2008) has suggested how various texts can be used to support the teaching of science or, in our case, STEAM, by providing avenues for investigative thinking to occur. For example, the dramatic story *The iron man* by Ted Hughes (1968) (also see Chap. 8) can be used to explore abstract concepts such as materials and their properties: physical processes—electricity and magnetism; *Stig of the dump* by Clive King (1963) lends itself to the investigation of forces and motion, while *Over the steamy swamp* by Paul Geraghty offers insights into life processes and living things. Oliver Jeffers' book *The heart in the bottle* (2010) provides a starting point for an investigation of the heart as a muscle, while also considering our reference to it as our emotional centre. In an attempt to shed some light on the evolution of certain organisms, Joyce Sidman and Beckie Prange combined poetry, factual information and illustrations in *Ubiquitous: Celebrating nature's survivors* (2010). Clearly, literature can provide opportunities for making connections between STEAM concepts and the students' own worlds and life experiences.

7 Integrating Science, Technology, Engineering and Mathematics with the Creative Arts

Let's now look at how some creative arts strategies and activities can be embedded in STEM. Where appropriate, teachers can adopt a thematic approach that relates STEM to a number of other subjects, including the creative arts. Topics could include, for example, the natural world, seasons, weather, plants and animals, the environment and machines. Remember that each of the following activities can be used as a starting point to engage the child's curiosity which leads to discovery and exploration.

Visual Arts

3D Habitats—when exploring an animal or plant's habitat, shoe boxes can be used to create representative dioramas. Add clay models, found objects and Papier-mâché in the construction. Ensure that students consider all the needs of the animal or plant.

Scientific Drawings—examine the detailed animal and plant drawings of Beatrix Potter or Sir Joseph Banks. Students complete a careful scientific drawing following this expert model, focusing on significant details. Photographs or actual plants can be used for direct observation.

Rock Paintings—each pupil selects a smallish rock. They carefully study its shape to see what it may become, that is, a frog, a bilby and so on. Add polyvinyl acetate (PVA) glue to paint so that it will adhere to the surface of the rock.

Art Versus Reality—students look at how the same object has been represented by various artists. For example, flowers depicted by Georgia O'Keefe, Van Gogh and Margaret Preston. The class decides on one object, and individuals are invited to interpret it through a range of mediums, including collage, water colour and ink, printing, pastels, clay and so on.

Music

Body Parts Rap—students use the bones of the body to create a rap or chant.

Nature Sounds—pupils tape-record sounds in nature such as magpies warbling, dogs barking, rain hitting a corrugated roof and so on. Using simple music software, they combine these sounds to create a nature composition.

Environmental Rhythms—as above, although this time, pupils record environmental sounds to create a musical composition. For example, a tap dripping, toilet flushing, door slamming, clock ticking and so on. These sounds could then be incorporated into a movement piece.

Musical Changes—after listening to Vivaldi's *Four seasons*, students write and record songs that detail either metamorphosis, growth or change. Some ideas may include seed to flower, caterpillar to butterfly, baby to old person.

Weather Reports—in small groups, students observe and then write weather reports. As the reports are read, the other group members act as meteorologists and provide the sound of the weather as it is mentioned, that is, rain, thunder and lightning, strong winds, hale and so on.

Drama

Conscience Alley—after researching an environmental issue such as global warming and loss of rainforests, students can be asked to generate plus and minuses for a particular issue. Students then form two lines (For and Against) facing each other. One pupil walks slowly down the middle, while students (one at a time) alternatively provide a reason for one side of the argument.

Embodiment—in order to understand scientific concepts relating to materials and their properties, students can embody them. For example, they can depict different states of matter—solids, liquids and gases. This activity can be further extended to processes such as evaporation, condensation, melting, freezing and boiling.

Tableaux (Frozen Moments)—small groups are given an Australian invention to research (e.g. Hills Hoist, cochlear implant, two-stoke motor mower, Speedo swimwear, etc). They research their invention and then create several frozen moments to replicate its first demonstration to the public.

Nature Metaphors—images of natural forms such as rivers, glaciers, sand dunes and so on can be studied closely. Students can choose a metaphor to represent their form and present it. For example, ‘dark as a bottomless hole’ (cave). Other members of the class attempt to guess the natural form being depicted.

Dance

Environmental Dance Moves—small collaborative groups are given an environmental category to research:

- seasons—spring, summer, autumn, winter;
- weather—sun-shower, thunderstorm, hail;
- life cycles—water, plant, butterfly; and
- places—beach, desert, the bush.

These can also be explored through movement using basic dance elements such as body, energy, space and time.

Machine Movements—observe things that move in a non-organic manner, for example, a toaster, a forklift, a mechanical toy and so on. Discuss the observations. In pairs, explore these kinds of movements, then demonstrate how different body parts at different levels/speeds can represent mechanical movements.

Walking Like—on cards write how to walk under different conditions:

- across slippery rocks;
- on hot sand at the beach;
- up a steep flight of stairs; and
- at an ice rink.

Students walk normally around the room. When the teacher calls out a description, they alter their walk accordingly. This activity could also include walking on the Moon which encourages students to consider the force of gravity.

Weather Dancing—in a unit on weather, students can select a weather condition preferably one that begins small and slow, escalates, slows and then stops, that is, a raging hailstorm, a bushfire and so on. All students start in a frozen position, when the narrator announces the weather condition, they respond by changing levels and shapes (one at a time) until they are all moving. When everyone is moving, they then reverse the process until all students are frozen again (Cornett 1999).

Example

A STEAM Unit Based on the Topic 'The Sea'

Aims

- to demonstrate that STEM and the Arts can be integrated with integrity;
- to explore the theme of 'The Sea' using recycled materials; and
- to acknowledge critical environmental issues around climate change, pollution and endangered flora and fauna.

Exploring (depending on age of students):

1. Watch a video segment which focuses on the beauty of the sea OR environmental concerns affecting our oceans.
2. In small groups, brainstorm what the term 'The Sea' means to you. Consider specific colours, sounds, shapes, living things, objects, activities and so on. This can be done via words, images or both.
3. In these same groups, use the brainstorming to create a piece of poetry or prose. Share with the other groups. Consider the similarities and differences between the different responses.
4. Students can digitally upload their poems adding images, video clips and/or sound effects.

Developing/Making

1. Create 'treasure boxes', using empty transparent CD cases or small cardboard boxes. The CD cases should have both a foreground and background while the boxes will have top and sides decorated.
2. Use different types of recycled/reused papers— Cellophane tissue, gift wrapping and magazine pictures. Small shells, driftwood, sand and other found objects can be used to decorate the treasure boxes. Use PVA glue versus clag as it will dry clear.
3. Students may also consider adding letters/words from magazines to their 3D forms.

Responding/Reflecting

1. Each group is given an artwork that in some way is associated with the sea.

Suggestions from *Beyond the frame* include:

Big shark in a small ute by Susan Fischer (1992);
Gift from the sea by Jorg Schmeisser (1990); and
Manly beach—Five girls on longboards by Ray Leighton (c1940).

From *Aspects of Australia:*
The bathers by Anne Zahalka (1989).
From *Sculpture by the Sea Education Kit*:
In your own backyard by Marianne Hulsbosch and Robyn Gibson (2002).

2. As a group list the similarities and differences between the artwork and the treasure boxes that have been created.
3. Students use their bodies to 'replicate' their artwork. All artworks are displayed and the rest of the class attempts to guess which is being displayed. Photographs should be taken so that each group can critique its own representation of the artwork.
4. As a class read some art auction blurbs from Sotheby's catalogues. Students then use this 'persuasive' style of language to write their own in order to sell their treasure boxes.
5. The teacher selects an 'auctioneer/s' who is tasked with selling each artwork to the highest bidder!

Extension Ideas

1. As a class discuss the children's concerns about the current state of our oceans, for example, raising sea levels, bleaching of coral reefs, sea life caught in disused fishing nets and so on. Play some quiet, contemplative music and ask students to write 'a prayer (message) to the sea' on small pieces of coloured card. These could be personal, community-focused or from a global perspective. They are to be enclosed inside each treasure box.
2. The treasure boxes can be incorporated into subsequent drama activities where they can be offered as 'gifts', and recipients respond with their understanding of:

a beautiful sea;
a dangerous ocean; and
a sad coral reef. ◄

Teacher's Reflection

This series of lessons can be adapted depending on the age, backgrounds and interests of the students. Teachers may want to take a 'hard look' at current global concerns or focus on a more positive appreciation of this natural resource. It does however demonstrate the ease with which the Arts can be integrated into a traditional science topic and result in truly unique artefacts! (Robyn Gibson)

Example

The Art and Science of Toys

This following unit of work links the science of toys with the creative arts. It was developed by Chris Preston, a science educator with extensive experience working with both primary students and pre-service teachers.

Visual Toys

To Begin

Image 12.7 Flip 'n flyer

In pairs examine the surfaces of the visual toys provided and discuss the following:

What do they have in common?

What colours, shapes, patterns and textures have been used to decorate these toys?

Think: have these features been used randomly or chosen with purpose?

Predict

These toys are all designed to spin and when they are moving, you see the surface travelling very quickly. Predict what will happen to:

(a) colours and

(b) shapes

as the toys spin. Record your predictions before testing them out.

Observe

In pairs play with the toys and observe what they look like when they are moving.

Do the colours change or remain the same—when the toy is moving fast or slow?

How do the surface patterns compare when the toys are in motion or still?

Make sure your partner has a turn.

Explain

Can you explain how this toy works? How does spinning these toys change the way in which we see them?

Create

The surface features of these toys can be changed without altering how they work. Design an add-on to the toy that would make it more artistic or appealing for the observer.

Consider: colours, textures, shapes, reflective or absorptive materials.

How would you change the toy if you were a toy designer?

Use either the modification you made to the toy or the toy itself as inspiration for an artwork. Think about what the toy looks like when it moves fast or slow, before it starts and as it slows down before it stops. You could use video or digital photography to capture the visual effects and use these as inspiration for your artwork. Consider whether your artwork should be 2D or 3D.

Extension Ideas

1. *Creating a visual toy*—look at the features of the Flip 'n flyer.

   What is it made from?

   Do you think you can make a toy that works the same way?

   Consider design features such as materials, shape of parts, weight of the disc, thickness and elasticity of the elastic.

   When you make your toy make sure the hole is exactly in the middle of your disc—why is this important? Also make sure any additional features, streamers, weights and so on are arranged evenly around the disc—why is this important?
2. *Illustrating how a toy works*—draw a labelled diagram of one of the toys you experimented with. Underneath list each part and explain its role in making the toy work. Imagine you were provided this illustration for a technical book on the science of toys.

   Consider: audience, visual appeal, clarity and key scientific concepts.
3. *Dancing with toys*—Visit the Flip 'n flyer website—watch videos of the toys being used. Each student plans a dance movement to correspond to the action of one of the toys. Pairs then combine their movements; two pairs join and create a continuous dance sequence that complements the action of the toy.

Flying Toys

Allow children to explore the range of flying toys available. These might include pump rockets, model aeroplanes, Frisbees, rubber band–powered helicopters, hand-driven rotor blades (linear), string-pulled rotor blades (circular) and flying saucers.

In pairs, have students select one of the toys and examine its features to try and work out what enables it to fly. Have them consider—what energy is applied to the toy and the energy changes that take place as it lifts, continues in motion and finally comes back to the ground. Ask students to draw a labelled diagram of their toy, showing the four forces involved in flight—gravity, thrust, lift and drag.

Image 12.8 Examples of flying toys

Have students write a brief explanation about the interplay of these forces in the operation of their toy.

As inspiration for an artwork about flying toys children might consider some of the following:

attaching things to the toy that add to its physical appearance or interest as it flies;

recording and representing the flight trajectories of the toy;

combining different toys, their size, shapes, features, way they fly and what they look like when they fly into one artwork; and

showing toys from different viewpoints (from on top, below, side on, front on) as they fly.

Extension

1. Pairs join together to form a group of four to compare and discuss the flying toys they examined; list the similarities and differences between them.
2. Develop a dance or a play using flying toys as inspiration; and
3. Listen to the sounds the flying toys make; can you put together a musical compilation based on these toys?

Marine Toys

Show children a range of marine animal toys, for example, octopus, squid, Grey Nurse Shark puppet, turtle, anemone fish, Blue Tang, crayfish, (pictured). As children handle and observe these toys from all sides ask questions to stimulate their thinking.

Which animals belong in the same group? What are the similarities and differences between the fish or between the squid and octopus? Look at the patterns on the fish, do you think they have a purpose or are just for decoration? (See interference colours and eye spots used in animal camouflage.) How accurately do the toys represent the real animals: colours; size; shape, fins or appendages?

Provide children with some photos (printed or displayed around the room or on an interactive whiteboard). Discuss the shapes that the patterns make and

Image 12.9 Marine toy display

ways that the pattern could be used to create an interesting artwork. Have children think about emphasising or exaggerating markings by focusing on details, using distortion and elongation, changing the viewpoint, or enlarging or reducing the scale. Rather than using the colours of the real marine organism have children experiment with changing the colours to alter the appearance and effect of the pattern.

Extension

As a class create a large-scale frieze of an environment that the marine organisms could live in. Groups of students can make their own habitat within the environment suitable for their organism to live in. Consider where the organism lives in the ocean, shallow or deep water, weed covered or rocky area. Place the organisms in their environment; display the frieze at the front of the room, while students move to the back to view. How many organisms are highly visible, visible, slightly visible, hardly visible or totally concealed?

Musical Toys

Provide children with a range of toys—some that are musical toys, for example, wind tube, rain stick, xylophone, maracas, toy castanets, hand drum, and some that are standard toys that make interesting noises, for example, spinning tops, slinky springs, balls, clappers and gravity toys.

Have children play with the toys, listening to the sounds they make. In preparation for the next part you might have them label or group the toys as those that make—high, low, loud and soft sounds—rhythmical or repetitive sounds—those that can be combined to make desirable sounds.

Before moving onto the next part, discuss the similarities and difference between the toys that make high sounds. What features of the toy control the type of sound it makes? Could you modify the toy to change its sound? How? Is this possible without damaging the toy? Repeat for low sounds, loud sounds and soft sounds.

Use the range of musical toys to construct a piece of music that emulates the sounds and sight of a particular environment, for example, rainforest, seaside, city street or outback plains. Children may need access to recordings of these environments to pick out characteristic sounds to incorporate into their piece of music or, alternatively, show static pictures and have children develop a sound scape to 'bring the picture to life'. ◄

Teacher's Reflection

This unit of work shows a variety of means of integrating science topics with creative arts that preserves the authenticity of each learning area. Toys are a resource that is readily available and can be provided by the students themselves linking learning with personal experiences. Using toys as teaching resources promotes positive attitudes towards learning because they are inherently fun and fascinating. Focused learning activities built around Science and Arts concepts lead children to consider familiar objects (toys) from different perspectives. The students learn to observe actions and features more closely and with purpose whilst thinking more deeply about how things work and what makes things happen. Essentially such activities open students' eyes and minds more about the world around them. (Christine Preston)

Example

The following integrated unit explores The Water Cycle. Written for students in Years 5 and 6 it can easily be adapted for other grades.

The Water (Hydrologic) Cycle

Purpose: students will come to understand the principles of the water cycle and that there are two important concepts to be aware of: change in shape and change in state.

Building the Field Knowledge

Session 1

Teacher and students discuss what they know about water and where our water for use at home comes from. Students will be amazed to learn that we may have just poured this glass of water but in actuality, it's ancient! Explain that we are going to learn how the water journeys from land to sky and back again.

Session 2

If possible, take students on an excursion to a local dam.

Sessions 3–5

Students undertake a range of experiments that demonstrate that water changes state. They boil water and see that it turns to gas, and then see it change back to liquid again. Water will also be frozen to see that it changes to ice (and that the ice has more volume). Introduce the terms evaporation, transpiration, condensation and precipitation.

Students record their observations with diagrams in their notebooks. They can also enact the various experiments with their bodies and think about how to represent what is happening. For example, they can change pace to indicate the water particles speeding up as they change to gas.

Session 6

Enact the water cycle in the hall, on a shaded part of the playground or in your classroom cleared to enable a lot of movement. Guided by the teacher, students become droplets of water and embody the change process as they are led through the various parts of the cycle (Image 12.10).

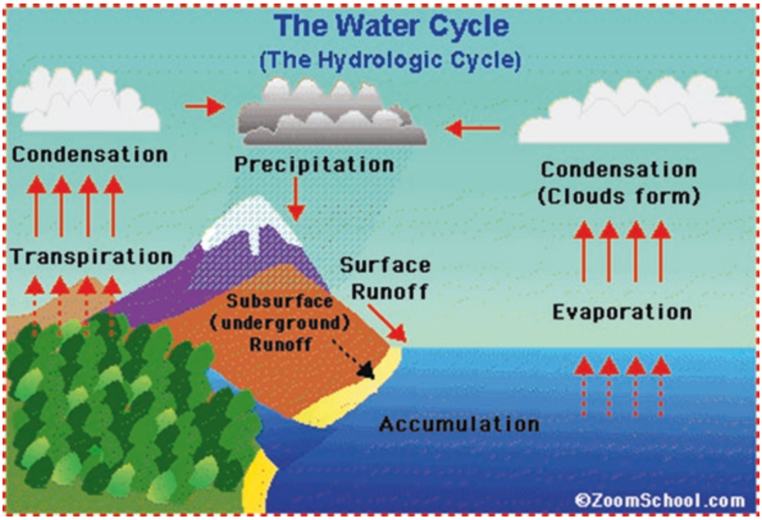

Image 12.10 The water cycle. (Source: http://www.enchantedlearning.com/subjects/ocean/Watercycle.shtml)

Session 6

Students work in small groups to take one of the important processes (evaporation, transpiration, condensation, precipitation, infiltration and run-off) to embody in a series of movement. Their presentations to the class can be used as an assessment task.

Session 7

In the same groups or new groups, students can translate their understanding of the various processes into a creative dance using music (e.g. Handel's water music).

This can be extended further to exploring the importance of clean water, conservation, the threat of water being contaminated and so on.

There are many resources to support the development of a unit of work around the water cycle. For example: http://www.woodlands-junior.kent.sch.uk/Homework/swater.html; http://www.enchantedlearning.com/subjects/ocean/Watercycle.shtml; Oxfam. ◀

8 Conclusion

If we want our students to be prepared to address the challenges of an uncertain future then we must ensure that the education we offer is as broad and comprehensive as possible. By adding the 'A' into the STEM equation, teachers may be persuaded to find meaningful ways to incorporate STEM concepts into the curriculum. This in turn may provide opportunities for self-expression and personal connection so often missing in today's schools.

Questions

1. The ancient Greeks promoted no hierarchy of subjects but a continuum of learning. They made no firm distinction between the Arts and the sciences. Were they the first proponents of STEAM?
2. What is the next STEM topic that your class will be investigating? Explore ways in which you could infuse the creative arts into this learning.
3. If you were to teach one of the units of work described in this chapter which would it be and why?

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Suggested Reading

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Useful Websites

http://enhancinged.wgbh.org/research/eeeee.html
https://educationcloset.com/what-is-steam-education-in-k-12-schools/