‘Sustainabilli-bees’

Year 3/4 STEM & Environmental Studies

Written By Allen Dickson

About the Unit…

This unit is centred around the life of Billie Bee – a little LEGO bee who will take us through learning about bees, their life in the hive and how we can learn more about the environment to increase our own sustain-a-Billie-Bee on this planet.

Undergirding Pedagogy

The unit is designed around a Story-Based Learning (SBL) pedagogy. This is an approach to education that utilises stories in a holistic, learner-centred and transformative way. In SBL the teacher intentionally designs experiences to tie in with a narrative (such as the story of Billie Bee). This narrative should engage the learner, develop empathy with characters within the story, and offer opportunities for that learner to challenge the story that they tell about themselves.

Story-Based Learning emphasises identity (story) and character (strengths) and can be matched to other learning approaches that emphasise knowledge, skill and competency acquisition. Approaches like play-based learning, inquiry-based learning, project-based learning, blended-learning and even direct instruction can all be connected with Story-Based Learning. I see so many connections with the intuitive way that LEGO can be used in the classroom and the way in which a LEGO build creates a story in itself.

SBL gives students the *tools* for challenging the story. Using LEGO to create that story gives the students *agency*.

To learn more about SBL, visit our website – www.storybasedlearning.com

Key Skills

- Manual Design Process (including engineering of LEGO BricQ Motion mechanisms)
- Coding Skills (LEGO Spike)
- Presentation and Public Speaking Skills

Assessment

- Peer Assessment – BricQ Motion Bee Mechanism
- Teacher and Peer Assessment (minor) – a-MAZE-ing Bees: Sensor Maze Challenge.
- Teacher and Peer Assessment (major) – Presentation rubric & Class Action Project vote based on presentations
- Teacher Assessment (minor) – Build-A-Bee: ‘Get To Know Your Bee’ Sheet.
- Teacher Assessment (major) – Waggle Dance Design & Program

Curriculum Links

- **Science**: All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival.
- **Values**: World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability.
- **Society and Environment**: The sustainability of ecological, social and economic systems is achieved through informed individual and community action that values local and global equity and fairness across generations into the future.

STEM Context

STEM in the Environment and Society

Relevant Gr3/4 Content Descriptors

Although this unit is primarily about STEM in the Environment and Society, the integrated nature of the unit encompasses an interdisciplinary approach. Therefore it draws upon the following subjects and incorporates the these Content Descriptors.

English

- understand that cooperation with others depends on shared understanding of social conventions, including turn-taking patterns, that vary according to the degree of formality in social situations (AC9E3L02)
- plan, create, rehearse and deliver short oral and/or multimodal presentations, providing key details in a logically organised way, for different purposes and audiences, using everyday and learned vocabulary, and vocal effects (AC9E3LY07)
- plan, create, rehearse and deliver a range of structured and coherent oral and/or multimodal presentations for different audiences and purposes, with integrated learned content, and a range of vocal effects for clarity (AC9E4LY07)

Science

- follow procedures to make and record observations, including making formal measurements using familiar scaled instruments and using digital technologies as appropriate (AC9S4I03)
- create multimodal texts to communicate findings and ideas for identified audiences, using digital technologies as appropriate (AC9S4I06)
- investigate the roles and interactions of consumers, producers and decomposers within a habitat and how food chains represent feeding relationships (AC9S4U01)
- investigate how forces can be exerted by one object on another and how frictional, gravitational and magnetic forces can affect the motion of objects (AC9S4U03)

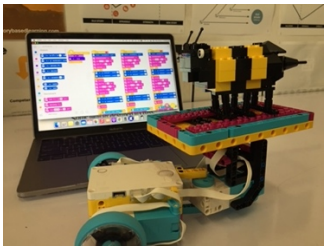
Maths

- measure, order and compare objects using familiar metric units of length, mass and capacity to solve practical problems (AC9M3M01)
- recognise which metric units are used to measure everyday items and use known measures and related units as a benchmark to make, improve and check the reasonableness of estimates (AC9M3M02)
- analyse, classify and make models of objects, identifying key features and explaining why these features make them suited to their uses (AC9M3SP01)

Technologies – Design & Technologies

- explore needs or opportunities for designing, and test materials, components, tools, equipment and processes needed to create designed solutions (AC9TDE4P01)
- select and use materials, components, tools, equipment and techniques to safely make designed solutions (AC9TDE4P03)
- develop criteria for success including care for the environment to evaluate design ideas and solutions (AC9TDE4P04)
- sequence steps to individually and collaboratively make designed solutions (AC9TDE4P05)

Technologies – Digital Technologies

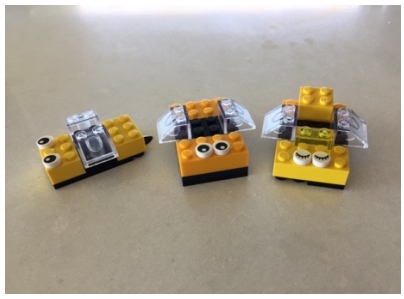


- explore and describe a range of digital systems and their peripherals for a variety of purposes (AC9TDI4K01)
- define problems with given design criteria and by co-creating user stories (AC9TDI4P01)
- follow and describe algorithms involving sequencing, comparison operators (branching), and iteration (AC9TDI4P02)
- generate, communicate and compare designs (AC9TDI4P03)
- implement simple algorithms as visual programs involving control structures, variables and user input (AC9TDI4P04)
- share information and collaborate with others demonstrating agreed behaviours, guided by trusted adults (AC9TDI4P07)

Building My Own LEGO Bees

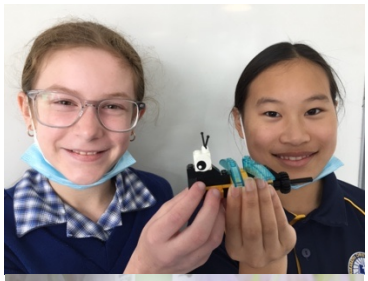
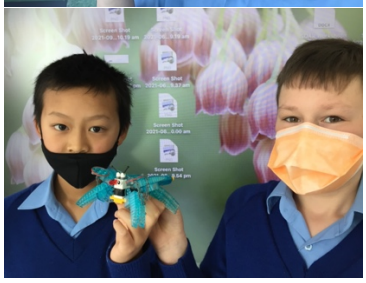
I had a lot of fun playing around with making LEGO Bees of different degrees of difficulty and using different sets. The main thing that I found is that it is relatively simple to build a small bee from simple black and yellow bricks – the trick is to accessorise to make it suit the role it will play in the hive. I had several students from Grades Prep-4 attempt to build their own little worker bees. Here are a couple of pictures of their efforts.



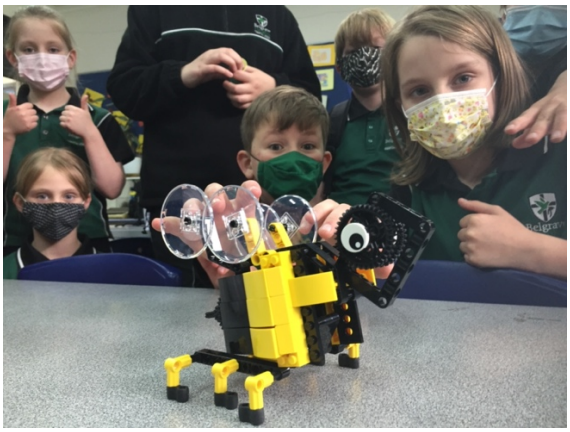
I also had a few Gr5/6 students (from another school where I run STEM activities) try and build some bees using some Wedo 2.0 kits. These were some of their creations.



LEGO Spike Kit
Although we use the LEGO Spike kit primarily for the Bug-Buggies in Lessons 4-7, we also tried to make some bigger bees just using the bricks in the Spike kits.

As a Gr3/4 class, this was the best bee that we could make using just the LEGO Spike kits… although we did use bricks from two sets… but this is our Queen Bea (aka Her Royal Hiveness Queen Beatrix Buzzalot IV).



Unlimited Bricks
I was fortunate enough to have a few of the older students at school come in and help in our Gr3/4 class. These students just love LEGO and were involved in our 'Lockdown Legomasters Competition' during Learn From Home. When I set them a challenge of making a bee… this was one of their creations and I think it is brilliant!

Take special note of the bee's legs – they are made of mini-fig arms!

School Context

One of the key influences in devising this unit is the fact that our school is bordered by a nature reserve and creek. Over the years, the school community has reclaimed the creek from being overgrown with every noxious weed known to the Dandenong Ranges. We have created reedbed swales to purify greywater run-off, developed a frog bog, planted thousands of trees and a group of students even developed a sensor for the creek (The Platypulse) to monitor water quality in the hope that the platypus will return… which they slowly are! Central to this riparian ecosystem is the native bee – the Teddy Bear Bee and the Blue Banded Bee. A benefit of this unit will hopefully be an increased awareness of what we – as a school – can do to encourage these pollinators, and to hopefully result in some projects around the school that make our bee population more sustainable.

The other influence that I had in devising this unit was a Facebook post from a friend of mine that came into my feed. In the current divisive and isolating climate of COVID, vaccination mandates and the effect that this has had upon my school, my colleagues and particularly my students, this story seems to be more relevant now than when I scrolled upon it a few months ago.

My friend didn't know the origin, who wrote it, or whether or not the story is true, but the lesson it contains teaches far more eloquently than any curriculum unit I could design.

The post read…

•••••3G 19:00 65%

facebook

Allen Dickson

#inspirationfortheunit #beekind #sustain-a-billie-bee

My dad has bees. Today he showed me the honey he had robbed from the hives. He showed me a 5 gallon bucket full of honey and on top of the honey were 3 little bees, struggling. They were covered in sticky honey and drowning. I asked him if we could help them and he said he was sure they wouldn't survive.

I asked if we could at least get them out and kill them quickly, after all he was the one who taught me to put a suffering animal (or bug) out of its misery. He finally conceded and scooped the bees out of the bucket. We put the three little bees in a container outside and left them to their fate.

Now because he had disrupted the hive with the earlier honey collection, there were bees flying all over outside.

My dad called me out a little while later. These three little bees were surrounded by all of their sisters – all of the bees are females – and they were cleaning the sticky but nearly dead bees, helping them to get all of the honey off of their bodies. We came back a short time later and there was only one little bee left in the container. She was still being tended to by her sisters.

When it was time for me to leave we checked one last time and all three of the bees had been cleaned enough to fly away and the container was empty.

Those three little bees lived because they were surrounded by family and friends who would not give up on them, family and friends who refused to let them drown in their own stickiness and resolved to help until the last little bee could be set free. We could all learn a thing or two from these bees.

Bee Sisters. Bee Peers. Bee Teammates.

But most importantly – Bee kind.

100 Likes 10 Comments

Like Comment Share

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Lesson One – Build-A-Bee

Lesson Summary:

In this lesson we will be introduced to the anatomy of a bee and the various roles that bees play in the hive. Students will design and construct their own bees out of LEGO, being mindful of the role the bee will play in the hive. Students will then present their creations to the class. These little bee-utiful creations will be what we use in the activities from week to week.

Criteria for Key Learning Outcomes:

- Students are able to identify the key anatomical features of a bee and the three main types of bees in a hive (queen, drone and worker bees).
- Students design, construct and present their own LEGO bee to the class, incorporating key features that pertain to the role of that bee in the hive.

Assessment Task:

Build-A-Bee: Get To Know Your Bee Sheet

Engage

(Whole Class: 10-15 minutes)

To Bee or Not To Bee… A Choose You Own Adventure Slideshow Story

Using a hyperlinked PowerPoint or Google Slides, the teacher reads through a 'chose your own adventure' story of the life of Billie Bee whilst the teacher 'builds' Billie at each stage of development. The whole class get to choose how Billie develops.

Essentially the story follows Billie as she/he hatches from an egg (a little yellow LEGO brick) in a little hexagonal cell (cut out of a yellow coloured A4 sheet of card). Billie grows into a larvae (the teacher adds eyes to the yellow brick) and the students are given a choice of three 'jellies' to eat:

- Jelly 1 (Worker Jelly) will take Billie down the path of a female Worker Bee.
- Jelly 2 (Drone Jelly) will take Billie down the storyline of a male Drone.
- Jelly 3 (Royal Jelly) will eventually make Billie into a Queen.

Depending upon what the students choose, the slideshow will hyperlink to that storyline… with its own choices and 'LEGO add-ons' to make either a:

- Worker – with choices to eventually be a Nurse, Undertaker, Honey-maker, Forager, Hive Guard or Queen's Attendant.
- Drone – who gets to hang out with the Queen but ends up kicked out of the hive in the Autumn.
- Queen – who eventually leaves the hive to start up her own colony.

For more information on the life cycle of a bee, have a look at the buzzaboutbees.net website – https://www.buzzaboutbees.net/honey-bee-life-cycle.html

Explore

(Whole class: 10 minutes. Then small groups of 2-4 students: 25 minutes)

Anatomy of a Bee

Guide the students through the anatomy of a bee – emphasizing the key elements of:

- a hard outer shell (exoskeleton)
- three main body parts (head, thorax and abdomen)
- a pair of antennae on their head
- three pairs of legs
- two pairs of wings

For a really good diagram and information on the anatomy of a bee, check out askabiologist.asu.edu. This website is awesome and will feature as a resource later in the unit – https://askabiologist.asu.edu/honey-bee-anatomy

Did you know… Bees have long tongues (called a proboscis) that they use to suck water and nectar.

Build-A-Bee

Students will then 'Build-A-Bee' from LEGO (much like the ones in the pictures below which were built using bricks from a Wedo 2.0 kit). They will firstly need to decide what role their bee will play in the hive (Nurse, Forager, Drone, Queen, etc) and then decide what 'creature feature' their design will include. Will it be a long stinger for a Guard Bee? Maybe a brush for the Queen's Attendants? Maybe just the big eyes of the Drone?

Note: There must be at least one Queen Bee in the class – this bee will have to be bigger than all the others.

Did you know… Worker Bees have an antennae cleaner on their foreleg and a pollen basket on their hindleg. The join on the hind leg also acts as a pollen press.

Once students have built their bee, they then have to name their bee. Just for a bit of fun, all of our Bee names are going to start with the letter B. Here are a few websites that have plenty of B names… but the internet has more of these 'baby name websites' than there are bees in a hive! So feel free to find your own.

100 Most Popular Baby Names in Australia for 2021…

Just in case you want to know, the most popular B names for girls included Billie at 52, Bonnie at 68 and Bella at 76. The most popular B names for boys were Benjamin at 32, Beau at 57, Bodhi at 86 and Billy at 96. Read more at Parenting Central.

Female Oriented B Names:

The Bump: Girl Names

Male Oriented B Names:

The Bump: Boy Names

Gender-Neutral B Names:
[The Bump: Gender-Neutral Names]

All (Male, Female & Neutral Combined) B Names:
[Babynames.com]

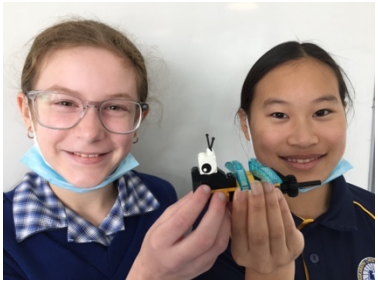
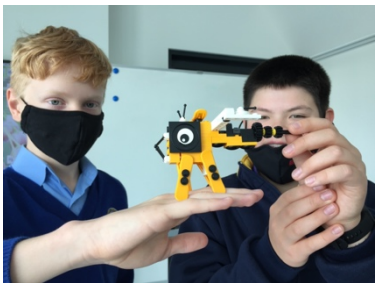
Did you know… Bees have smelly feet. Bees can leave each other messages by leaving smelly footprints on a flower to say that they have already taken all the nectar. When another bee lands on the flower, it knows to move on. The smell disappears by the time the flower is full of nectar again.

Explain

(Whole class: 10-15 minutes)

This is my Bee…

Students introduce their bee to the class. They talk about why they named their bee Bobby or Bindi or Bertram or Buzz… and they describe to the class why their bee is suited to the role they have chosen for it in the hive (Forager, Honey-maker, Drone, Queen, etc). In particular, they have to say what aspect of their LEGO bee construction is specific to their bee's job:


- My Foraging Bee is called Blossom and she has a backpack that can be used for carrying pollen back to the hive.
- My Guard Bee is called Boudicca (after the Celtic warrior) and she has a fierce stinger to protect the hive from wasps.
- My Drone has big eyes and his name is Brian… he doesn't do much… but he thinks the queen is hot.
- This is the Queen Bee. Her name is Bree because she breeds all the time and you can see that she is way bigger than all the other bees – around twice the size.



For more information about the roles of bees in the hive, visit the '9 Hive Jobs of Honey Bees' page of the hobbyfarms.com website - https://www.hobbyfarms.com/9-hive-jobs-of-honey-bees-2/

Elaborate

(Individual: 15 minutes)

Build-A-Bee: Get To Know Your Bee Sheet

Using the photocopied sheet 'Build-A-Bee: Get To Know Your Bee', students will sketch and colour a picture of their bee, labelling the anatomical elements. There is also a space for the students to record their 'creature feature' – the element of their design which is specific to the role their bee will play in the hive.

The students can also fill in the table at the side, recording their bee's name, favourite activity, dislikes, etc.

If needing extension, students can use the lined space below their picture to write a short story about their bee and an adventure it had when it decided to 'Bee Curious'.

Evaluate

Keep an eye on the social interactions between the students as they build. Encourage them to share ideas – especially in the design and discussion phase.

Observe which groups are struggling to begin their build. Reassure them that with LEGO, if you don't like what you've built, you can always pull it apart and try a new design. After all…

We make it to break it!

This is my mantra when building with LEGO as it encourages students to focus on the design and the build, rather than keeping the finished product 'sacred' and untouchable.

After the students have presented their bee, affirm their efforts by having someone from the class say what they really liked about their explanation and their bee design.

Extra

Play Bee Chess.

Now that you have made the bees, why not use everyone's bees to play a giant game of Bee Chess? Simply lay out some alternating coloured paper to make the chessboard (8x8) and then group the pieces as follows:

- The regular Worker Bees are the Pawns.
- Small Hives are the Rooks.

- Drones (with their big eyes) are the Knights.
- Queen's Attendants (worker bees who have been 'promoted' to look after the Queen Bee) are the Bishops.
- The Guard Bee is the hive equivalent of a regular Queen in chess. This strong female has the most mature stinger and is the most lethal of all.
- Of course a hive doesn't have a King – so the Queen Bee takes the place of a regular King in a game of Bee Chess.

To delineate the yellow swarm and black swarm, just place a black 1x1 LEGO brick on each bee in the black team.

If you don't have enough bees to field two teams, feel free to use different coloured LEGO bricks as the opposing team (eg all red bricks are pawns, green are rooks, etc).

Early Start for Next Lesson

If you have some students who finished their builds with plenty of time to spare, give them a LEGO BricQ Motion kit and have them design and construct a set of scales for the next lesson. The scales should look like this picture (but maybe without the boxes), and be big enough to weigh several of our bees at once.

Lessons Two & Three – Stayin' A-Hive

Lesson Summary:
This lesson will be split over two sessions and will look the idea of balance – both socially in the hive and literally balancing the weight of our bees. Then students will move into small groups and create a mechanism that demonstrates or aids a bee in their 'job' in the hive. These designs will be based upon some of the builds in the BricQ Motion series, but will be adapted and redesigned to aid the particular bee in their task.

Criteria for Key Learning Outcomes:
- Students are able to estimate the weight of their bee comparative to other bees.
- Students learn the key terms: lever, fulcrum, force and load.
- Students design, adapt and construct a simple machine (using LEGO BricQ Motion) to aid their bee's function in the hive.

Assessment Task:
Peer Assessment – BricQ Motion Bee Mechanism

Equip (Prepare)
Before the lesson, use the BricQ Motion kit to construct a set of scales that pivot in the middle.

Teacher Tip: There are a lot of online examples with instructions that look a bit like this picture. Try searching for 'LEGO weighing scales' rather than LEGO scales as that search will bring up all sorts of information about the scale (ratio) of the LEGO Star Wars series (Millennium Falcon, X-Wings, etc).

Of course, we are going to be weighing our bees… so we will need a set of scales much bigger!

Note: If you want to save a bit of time and have some students who need some extra 'hands on' attention, why not give the construction of our BricQ Motion scales to them BEFORE the lesson?

Engage
(Whole Class: 10 minutes)
Begin by telling a little story about our intrepid little friend Billie Bee. In the story Billie – a Worker Bee – is finding it hard to decide upon what role she should be playing in 'Hive Life'.

If you really want to make it atmospheric, play some background music of 'Stayin' Alive' by the 'Bee' Gees… Oh the tight pants and teeth! Or even the more modern version of Stayin' Alive by n-trance (but it does mention beer).

Now Billie knows that every role is important for the hive to thrive – from Nurse bees to Queen's Attendants.

She began as a Cleaner Bee cleaning out the hive to minimize the chance of disease. The she tried her hand at being an Undertaker Bee, getting rid of the bees who have literally worked themselves to death. She had a turn at being a Nurse Bee, feeding the young larvae 10,000 times a day (and you thought teaching Primary kids was hard!).

Billie could see some of the more mature Honey-maker Bees working hard over the cells converting the nectar into honey. And she even hitched a flight with a Forager Bee, braving the outside world as with all its bright colours, sweet flowers… and dangerous enemies like wasps and those big clumsy things called humans.

She had always wanted to be a Queen's Attendant… but she soon realises that looking after her sisters and the long term survival of the hive is most important of all.

Perhaps she might end up as a Guard Bee and protect the hive from mice and invader bees?

But no matter what role she decides to do, it's always tough work stayin' a-hive!

Did you know… Apiarists (beekeepers) don't estimate the number of bees in a hive by counting. They measure bees by the cupful; one metric cup of honey bees equals around 600 bees. A healthy honey bee colony contains between 30,000 and 60,000 bees… that's up to 100 cups of bees!

Explain

(Whole class: 10-15 minutes)

Remind the students that 'Stayin' Alive in the Hive' – it's all about getting the balance right.

As a class, line up all of the bees. Ask the students to arrange them in order of size.

- Are there similarities between the size of our bees and the role that the bees play in the hive? For example, the Queen is by far the largest bee. Which is the next biggest? Which type of bee is the smallest?

Next, have the class arrange the bees according to weight.

- What makes some bees heavier than others? Is it the design? Or does it have to do with the role that the bee plays in the hive?
- Is there a connection between the size of the bee (length, width and/or height) and the weight of the bee?

Now introduce the Scales and explain the technical name for each part… using a seesaw as an analogy might help.

- We call the flat piece on top of the scales the lever.
- The point on which it pivots is called the fulcrum.
- The energy exerted in pushing up or down is called the Force (Use the force Luke).

- The weight on the lever is called the Load.

Pose these three questions:

- What is the main force you encounter on a seesaw?
- Is weight different to size?
- Can we change the 'balance' of force and load using a lever?

Explore

(Whole class: 15 minutes)

Bee is for Balance

Next, using the set of scales (which were constructed earlier with the BricQ Motion kits), compare the weights of various bees.

- Which ones are heavier?
- How many Worker bees does it take to balance with a Queen?
- Like on a see-saw, what happens when you place one of the bees closer to the middle? What happens when you move them further towards the end?
- Is there a way that you can balance a Worker with the Queen by moving their positions on the scales?
- Can we make some 'rules' about what happens as we change the weight distribution on the lever?

You potentially could do a deep dive into Archimedes and his laws of levers and pulleys (or align your concomitant Science lessons). For more information on Archimedes and levers see encyclopedia.com or simply google 'Cool lessons for Levers and Pulleys' or 'Lessons for kids Archimedes'… there are heaps of great ideas out there!

Did you know… A queen bee can lay twice it's body weight in eggs each day – that's about 2500 eggs in a single day.

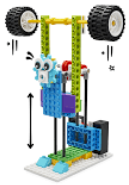
Elaborate

(Small Groups: This build will spread over two sessions.)

Bee is for Build

In pairs or small groups, student now have the opportunity to build their own mechanism to help their bee in its chosen role in the hive. Dependent upon their bee, they will look at one of the BricQ Motion builds outlined below (both online and in the instruction booklets) and adapt it to create a simple machine that will help the bee contribute to Hive Life.

Cleaner Bees might make a design that can sweep a cell clean… perhaps using the same mechanisms as the hockey players on page 12 of the BricQ Motion instruction booklet.



Undertaker Bees might have to lower a coffin out of the hive… perhaps using the same pulley system as the weightlifter on page 68 of the BricQ Motion instruction booklet.

Nurse Bees need an automated feeder chute for the larvae… perhaps using the same mechanisms as the slide for the bobsledders on page 40 of the BricQ Motion instruction booklet hard.

Honey-maker Bees are constantly having to dip their heads into the honey cells to convert the nectar into honey… perhaps using the same mechanisms as the cheering crowd from the online BricQ Motion 'Winning With Science' unit (Lesson 7).

Forager Bees need to land on flowers… perhaps using the same mechanisms as the free throw catapult on page 20 of the BricQ Motion instruction booklet. Or maybe they need a ratchetting proboscis to extend into the flower to reach the nectar… perhaps using the same mechanisms as in the Track and Field from the online BricQ Motion 'Winning With Science' unit (Lesson 1).

Queen's Attendants are constantly running to and fro, delivering and disposing of supplies for the Queen… perhaps using the same mechanisms as in the Track and Field from the online BricQ Motion 'Winning With Science' unit (Lesson 1).

Guard Bees protect the hive from mice and other invader bees… perhaps creating a fighting routine using the same mechanisms as the cheering crowd from the online BricQ Motion 'Winning With Science' unit (Lesson 7). Or maybe a sequence of fighting moves using the animation cog mechanism on page 4 of the BricQ Motion instruction booklet.

Note: If your school also has a LEGO Wedo 2.0 set, assign one Wedo kit to a pair of students. Have them create the guided bee tutorial in the 'Plants and Pollinators' section of the 'Guided Projects'. This cute little bee flies around in a circle and stops above the flower when the motion sensor is triggered.

Evaluate

Students demonstrate their BricQ creations to one another and students fill in a Peer Assessment Feedback sheet as a part of their formative assessment in the unit. They colour in stars for a score out of 5 in each of the following categories (total score /20):

- Originality of the build
- Usefulness of the build in hive life
- Technical difficulty of the build
- Overall awesomeness of the build

Extra

Bee Balanced

Using the 'Tightrope Walker' project on page 48 of the BricQ Motion Essentials instruction booklet as a basis, students can create an adaptation to find their little bee's centre of gravity. Whichever student/s make this tightrope creation could then share it with the class and every bee could find its centre (couldn't we all do with a little extra time to find our centre?).

Lessons Four & Five – Waggle It (Just A Little Bit)

Lesson Summary:

These lessons will be delivered over two sessions and will use LEGO Spike. In them we will look at the ways that bees communicate the location of a new food source – via the Waggle Dance.

Criteria for Key Learning Outcomes:

- Students can understand the ways in which bees communicate.
- Students design, create and code a Bug Buggy using LEGO Spike.

Assessment Task:

Teacher Assessment (major) – Waggle Dance Design & Program

Engage

(Whole Class: 10-15 minutes)

Starting Lesson 4: Treasure Hunt

Before the lesson, hide several 'prizes' in places around the room. Depending upon your class, these prizes could be special LEGO accessories, fun erasers, chocolate bees… anything that you think the class would be excited to find.

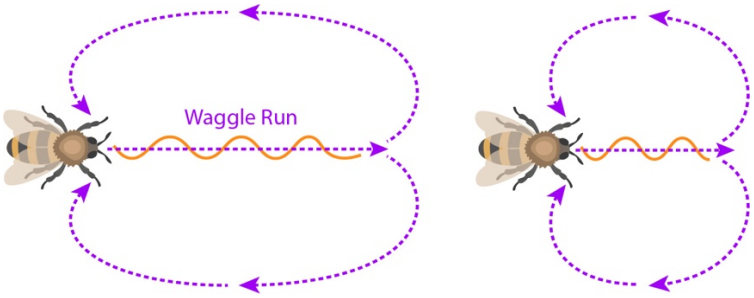
To begin the lesson, sit the students in a circle on the mat, then tell them you have hidden some prizes around the room… but are going to communicate where those prizes are without words… and you are not allowed to use your hands to point either!

Note: You might like to have some music playing throughout your Waggle dance Treasure Hunt. Maybe try Wiggle It by 2 In A Room, Wiggle It by Koo Koo Kanga Roo, or whatever you like…

Then, start to walk around the inside of the circle. This is the Round Dance that gets all of the other bees' attention. Then, when you have everyone's attention, start to do the Waggle Dance.

The Waggle Dance is the way that bees communicate the location (distance-to and direction-of) of a new food source (such as blossoms or flowers).

So once you have everyone's attention, you will then start to walk a 'figure eight' – but in the cross-over, you need to walk in the direction of the first hidden prize… waggling your backside as you do your 'Waggle Run'. The line you take will be in the direction of the prize, and the length (time taken) of your waggle will indicate if the prize is near or far.



Picture credit: https://askabiologist.asu.edu/bee-dance-game/introduction.html

As the students begin to 'understand' your communication, have the student who finds the prize be the next 'waggle dancer' (whisper to them where the next prize is). Continue this until all of the prizes have been found.

Starting Lesson 5: Just Dance
For beginning the second lesson on this topic, why not begin the class with this Youtube clip of Phineus and Ferb – The Waggle Dance. The students could dance along before getting back to their Bug Buggy builds.

Explain

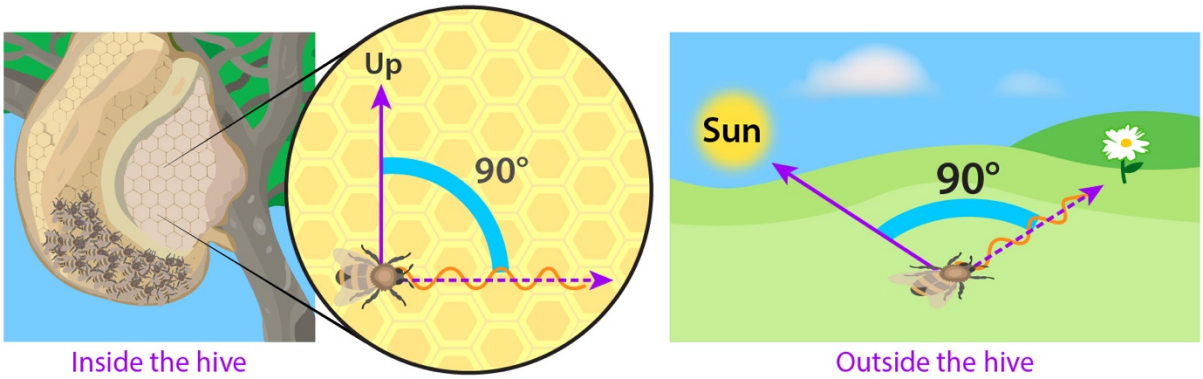
(Whole class: 15-20 minutes)
The Waggle Dance – Bee Communication
Discuss the Treasure Hunt with the students.

- How did they know where each prize was?
- Why was the Circle Dance important at the start?
- Was there a difference between waggle dances?
- Why were some waggles longer than others?

Did you know… Austrian Karl von Frisch won a Nobel Prize in 1973 for discovering the 'waggle dance' that bees use to communicate the location of new food sources.

Explain how bees communicate with their Waggle Dance. Discuss how the length of the waggle determines the distance from the hive, but also how the direction of the waggle run determines the angle that the bees need to follow.

You see, the bees perform their waggle dance on the wall of the hive (not flat on the floor like us). This way they always know which direction is up and so can figure out the angle of the waggle run. When they leave the hive, the position of the sun takes the place of 'up' and the bees fly off on that angle to find the new food source.



Picture credit: https://askabiologist.asu.edu/bee-dance-game/introduction.html

The other brilliant thing about the waggle dance is that it shakes out some pollen and the scent of the flower, helping the bees to know the smell and pollen count of the new food source.

Bees are super-clever!

Did you know… A bee also uses its feet to feel, taste and smell its world, and they are so sensitive that their feet can 'feel' when another bee is dancing.

As a class, demonstrate the online Bee Dance Game from askabiologist.asu.net. This should reinforce the notions of distance and direction.

Explore

(In small groups of 2-4 students: 30-40 minutes each lesson)

Create a Bug-Buggy: Waggle Dance

Students use LEGO Spike to create a 'Bug-buggy' that will carry their bee. This buggy will need to be programmed to drive in a waggle dance figure eight pattern (semi-circle, straight line with a waggle, semi-circle, straight line with a waggle: repeat)

If students wish to follow a tutorial build for their Bug-Buggy, the Rhino Body would be a great basis. Or if they wanted to make things a little more complex, the Delivery Cart tutorial build also could be easily adapted. Or they could try their hand at designing and building something totally original and new.

Have a look at these following attempts by students. What can you learn from each?

Hybrid Bug Buggy-Bee Prototype

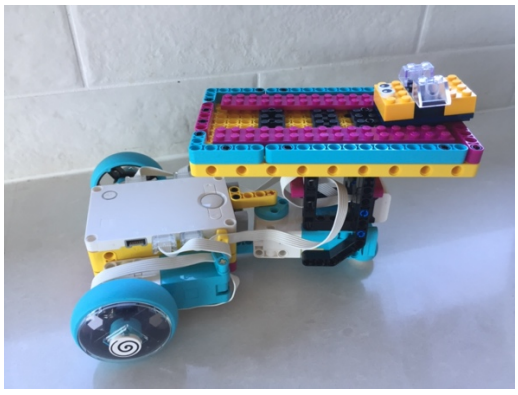
Here is an example of a hybrid 'Bug Buggy-Bee' that two Gr3/4 students made as we were experimenting with designs. This little creature has two motors that essentially drive it in a straight line, but with breaks in the program to turn right and left. This gave it a kind of waggle.

Although clever, the design didn't really meet the brief as it couldn't move in a figure eight. To turn in a figure eight you need to have one rear wheel turning faster than the other.

Imogen's Bug Buggy

One of my Secondary helpers (Imogen) created this Bug Buggy. It has two independent motors for the front wheels so that it can turn in a figure eight. The buggy's platform has a motor which can wiggle back and forth to create the waggle.

Combining the two means that our bees can Waggle Dance!



Check out the YouTube video of it in operation – Imogen's Bee Waggle Dance https://youtu.be/MeKUb4qFm0E

Bug Buggy Prototype
As a class the Gr3/4s created a little Bug Buggy prototype that has the bee 'hovering' on a pole above the buggy (the bee is interchangeable if some students struggle to complete their Bug Buggy). With two independent motors at the rear, this design is simple enough to build, but also meets all the requirements needed to travel in a figure eight and 'waggle'. However the coding chain is longer as the waggle is not independent from the forward drive.

Did you know… The largest species of bee is thought to be Wallace's giant bee (*Megachile pluto*) whose females can measure 39mm. The smallest species may be the dwarf stingless bees in the tribe *Meliponini* whose mature workers are less than 2mm from antennae to non-existent sting.

Elaborate

(Individual/Small Group Presentation to the class)
Once the students have created and coded their Bug Buggies, they can present them to the class. More than just simply showing their Bug Buggy in action, they need to talk about why they made the design choices that they made.

- Why did they choose to put wheels at the front or at the back… or both?
- Is the waggle independent of the wheels?
- How did they achieve travelling in a curve?
- Did they use a repeat or loop function?
- What was the hardest part of the dance to design?
- What was the easiest?
- What did you enjoy the most in the build?

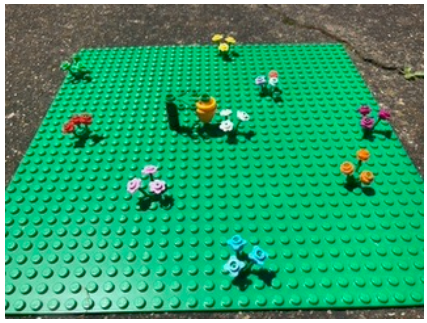
Evaluate

Students are graded upon the success and complexity of their build. The rubric (still to be developed) will also have a space for their own self-evaluation and reflection.

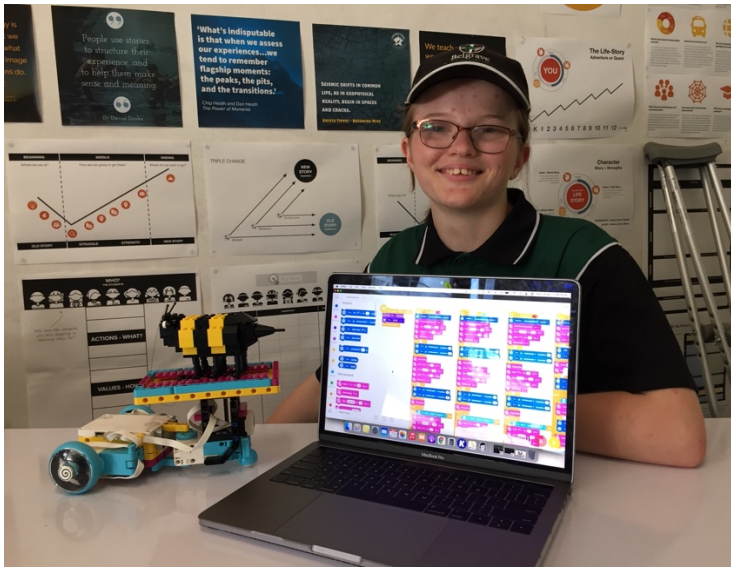
Extra/Extension

Find The Flowers

If a group of students are particularly advanced in their coding skills, have the students incorporate a colour sensor into the build. Students can design a 'field' of flowers with a hive in the centre… and with the different coloured flowers set at varying distances and directions (as in the picture) they can create several waggle dances. They will then use the colour to trigger a program that does a waggle dance to describe which flower they are finding.



In this example using Imogen's Bug Buggy, the colour sensor is mounted on the back. And here is Imogen with her code that creates the right distance and direction waggle dance for each of the corresponding colours of the flowers in the field (above).



She's a clever little cookie… and she is really proud of what she made…

…and the Gr3/4 kids thought it was amazing!

Lessons Six & Seven – A-Mazing Bees

Lesson Summary:

In these two lessons we will add either an ultrasonic, colour or touch sensor into our 'Bug Buggy' and then program them to navigate our bees through a maze back to their hive.

The maze will have some coloured flowers which will act as bonuses for our bees. But our maze will also have several 'hazards' which will threaten the bees in our colony – dangers like the effect of climate change on habitat, urbanisation, introduced species (like European wasps), etc. These literally will be 'dead ends' in our maze. The underlying message is to raise awareness of these hazards in preparation for the final lessons, where students get to 'pitch' their solutions in their Class Action Presentation (CAP).

The idea will be that the student's bees can accumulate points in the maze by passing through the flower sections, and have points deducted by hitting the hazards. Which sensor choice will be most effective in navigating the maze?

Criteria for Key Learning Outcomes:

- Students identify potential threats to bee colonies.
- Students recognise that bee and humans don't see colours in the same way.
- Students learn about sensors – ultrasonic, touch and colour.
- Students design, adapt and code their Bug Buggy using LEGO Spike to navigate a maze.

Assessment Task:

Teacher and Peer Assessment (minor) – a-MAZE-ing Bees: Sensor Maze Challenge.

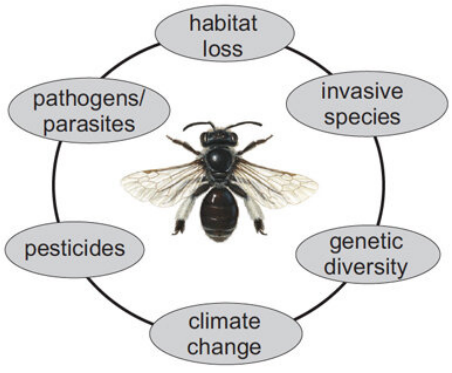
Engage

(Whole Class: 10-15 minutes)

Lesson Six – Bee Protective

Begin by putting on a Bee Keeper's suit and telling another little story about Billie the bee… but today's story focuses on the dangers that confront bees.

In the same way that I am wearing a suit to protect me, how can we help protect Billie (and by extension, all bees) from these potential threats?



The most pressing threats to long-term bee survival include:

- Climate change
- Habitat loss and urbanisation
- Invasive plants and other insects
- Low genetic diversity
- Pathogens and parasites spread by commercially managed bees (mites, etc)
- Pesticides

Starting Lesson Seven – Bee Seen: Seeing Things Differently

To begin the second lesson in this part of the unit, the teacher will hold up an eye chart that has various coloured letters on it. When we see this with just our normal vision, it seems like a random collection of letters.

But then the students will try on some glasses with red cellophane. The red cellophane filters out the yellow, orange and red letters to reveal a hidden message – I C DIFFERENTLY TO YOU.

And then putting on the glasses with green cellophane filters out the blue, purple and green letters revealing the message – U R A ONE OFF VIEW.

The basic take-away from this activity is that sometimes we have to see things from a different point of view to fully understand it.

Explore

(Whole class and then small groups of 2-4 students: 20 minutes)
Student will explore the various sensors (touch, colour and ultrasonic) and then add their sensor of choice to their Bug Buggy. Then they will create an 'if-then' code that repeats to navigate their bee through the maze.

Explain

(Whole class: 10-15 minutes)
Following on from the Eye Chart activity in Lesson 7, explain to the students how a bee 'sees'.

Honey bees (like most insects) can see most colours you and I can see— greens, blues and violets. But bees cannot see some yellows, reds and oranges very well; to them reds probably seem shades of grey or black. But bees can see a colour that we humans can't – ultraviolet (or what we abbreviate to UV).

Humans eyes see the flower in this picture as yellow (left). But when seen through a UV camera (right), the flower has colours that guide a bee to the source of the nectar.

These are called 'nectar guides'. Bees use these guides to find nectar. The flower uses them to entice the bee towards the reproductive parts of the flower to increase pollination.

Did you know… Bees actually have two types of eyes – the large compound eyes (to detect light) and the ocelli (small eyes on the top of the head that detect motion).


Elaborate

(Individual or small group: 20 minutes)

What is CCD?

Following on from the 'Bee Protective' activity in Lesson 6, students will delve into looking at the reasons for CCD – Colony Collapse Disorder.

Since 2007 bee numbers have declined dramatically… and honey bees aren't the only bees at risk. At least 45% of Europe's bumblebees are in population decline due to habitat fragmentation and loss of foraging plants. In North America, four species of bumblebees are in decline and one is already extinct. We know much less about the conservation status of our Australian native bees as some are solitary, colonies are generally smaller, and none are used in commercially viable production. Internationally, CCD brought public attention to the importance of pollinators, human impact on their health, and the global consequences of the potential loss of bees.

Colony collapse disorder (CCD) can occur due to any one and/or a mix of the following factors: • Diseases (pathogens) • Parasites • Pesticides • Long-distance transportation of colonies • Winter survival rates • Limited or declining floral resources • Fluctuations in the honey price (causing apiarists to cut costs and sacrifice hive welfare)	

Between the two lessons, students will research a potential hazard for our maze – ideally a hazard drawn from the list above. Researching the threats will not only inform and make more pertinent the 'dead ends' in the maze, but it will also prime the students for their WAX CAP in Lesson 8 – Bee Kind.

Did you know… Cretaceous bees and their wasp-like ancestors have been around for 120 million years. We know this because ancient bees became stuck in tree sap and now are preserved in amber, a semi-precious gemstone made of fossilised tree resin.

Evaluate

Each bee's Bug Buggy will have a chance to make it through the maze using an 'if-then' program on repeat.

- If they make it out of the maze, they receive 10 points.
- If they encounter a flower, they gain a point.
- If they encounter a hazard, minus one point.
- If they get stuck in a dead end… all points are lost.
- Total points are added together and contribute to their Peer Assessment Mark.

In addition to this, each students get three LEGO bricks. They place the bricks in a container in front of each Bug Buggy. They cannot place their brick in their own container. Each of the three bricks is awarded for a different aspect of the challenge:

- One brick is 'The Awesome Brick' – this one is awarded to the bug-buggy with the coolest design.
- One brick is 'The Skill Brick' – this one is awarded to the bug-buggy that best suited the challenge.
- One brick is 'The Pity Brick' – this one is awarded to the bug-buggy that should have done better but something went awry and it didn't do as well as it should have.

The bricks are counted up and the top three get 10 points, the next three get 8 points, then next three get 6 points, etc. These points are added to the total points from completing the maze challenge.

The Teacher Assessment is according to a design and application rubric (still to be developed). The two assessments are combined to achieve the total grade.

Extra

I C UV Bee Facts

Have some hidden 'bee facts' written with a UV pen on paper flowers and use a UV torch to reveal them. Or better still, have some of your students who need extending research the facts and then write up the bee fact flowers themselves. Then have these students guide the rest of the class through their secret bee bouquet facts!

Lesson Eight – Bee Kind

Lesson Summary:
In this final lesson we will look at a different kind of story – one where *we* make the ending.

The class teacher will present the WAX CEL… then it is up to the students to devise their own WAX CAP – Class Action Presentation.

Criteria for Key Learning Outcomes:
- Students identify a threat to the bee population, collaborate and design a solution.
- Students create and deliver a presentation to the class.

Assessment Task:
Teacher and Peer Assessment (major) – Presentation rubric & Class Action Project vote based on presentations

Engage

(Whole Class: 10-15 minutes)
Introduce the narrative that the students are a part of WAX – Worldwide Action eXchange. Every year WAX has a CEL – a Community Education Lesson – where student WAXers learn about a global issue in order to create their own CAP… Class Action Presentations (to initiate a Class Action Project).

This year's WAX CEL is all about the declining bee populations around the world. The WAX CEL raises concerns about pathogens, parasites and pesticides, but the real focus of the CEL is around what schools can do to maximise an environment that encourages bees, whilst still minimising activities that damage the environment.

So the students have to finish this story… by creating their own WAX CAP.

Each pair or small group of students will design their own presentation that uses their bee and other LEGO constructions as visual aids. Their Class Action Presentation (CAP) could be about creating a bee friendly garden, a way to educate Kinder kiddies about native bees like the Teddy Bear Bee, or a demonstration of environmentally friendly cleaning products that the class could adopt to reduce pesticide and chemical usage. Their choice in trying to make an environment more sustainable for bee colonies could result in a myriad of potential class projects.

Explore

(Small groups of 2-4 students: 30-40 minutes)
Students devise and script their own WAX CAP – complete with LEGO visual aids.

Explain

(Whole class: 20 minutes)
The students present their WAX CAPS.

Elaborate

(Whole class: 10 minutes)
The teacher leads the class in a discussion around the merits of each CAP. Eventually the class will vote and decide upon which CAP fits – which Action Project can they (as a whole class) enact in the school to encourage the bee population and greater sustain-a-billie-bee in general?

The hope is that the class will actually take up their CAP and make it happen… or at the very least it will change the way they think about the environment. That would make it a 'thinking CAP' – boom!

Evaluate

Students are assessed in two ways:

- Teacher assessment – Presentation rubric
- Peer Assessment – Class Action Project vote based on presentations

But the real assessment of the entire unit – the assessment that actually matters – is what the students transfer from the story of their bee into their lives. If they can somehow transform aspects of the bees and hive life into the way in which they treat their own colony and fellow workers – if they can do that, then the unit has been more than simply learning about bees. It has been learning about themselves.

As a teacher you will see this in the care that they display towards their bee. You will hear it in the anecdotes they tell about how they worked together. And you will see it in the authentic solutions they devise (and own) in deciding as a class to do something that matters.

If they do this, you've given them more than a lesson. You've given them an experience that becomes a part of who they are.

Bee proud.

Extra

To finish the unit, why not read out the Facebook post that was one of the key influences in my creating this unit. I'm not sure whether or not the story is true, but the lesson it contains teaches far more eloquently than any curriculum unit I could design.

•••••3G 19:00 65%

facebook

Allen Dickson

#inspirationfortheunit #beekind #sustain-a-billie-bee

My dad has bees. Today he showed me the honey he had robbed from the hives. He showed me a 5 gallon bucket full of honey and on top of the honey were 3 little bees, struggling. They were covered in sticky honey and drowning. I asked him if we could help them and he said he was sure they wouldn't survive.

I asked if we could at least get them out and kill them quickly, after all he was the one who taught me to put a suffering animal (or bug) out of its misery. He finally conceded and scooped the bees out of the bucket. We put the three little bees in a container outside and left them to their fate.

Now because he had disrupted the hive with the earlier honey collection, there were bees flying all over outside.

My dad called me out a little while later. These three little bees were surrounded by all of their sisters – all of the bees are females – and they were cleaning the sticky but nearly dead bees, helping them to get all of the honey off of their bodies. We came back a short time later and there was only one little bee left in the container. She was still being tended to by her sisters.

When it was time for me to leave we checked one last time and all three of the bees had been cleaned enough to fly away and the container was empty.

Those three little bees lived because they were surrounded by family and friends who would not give up on them, family and friends who refused to let them drown in their own stickiness and resolved to help until the last little bee could be set free. We could all learn a thing or two from these bees.

Bee Sisters. Bee Peers. Bee Teammates.

But most importantly – Bee kind.

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