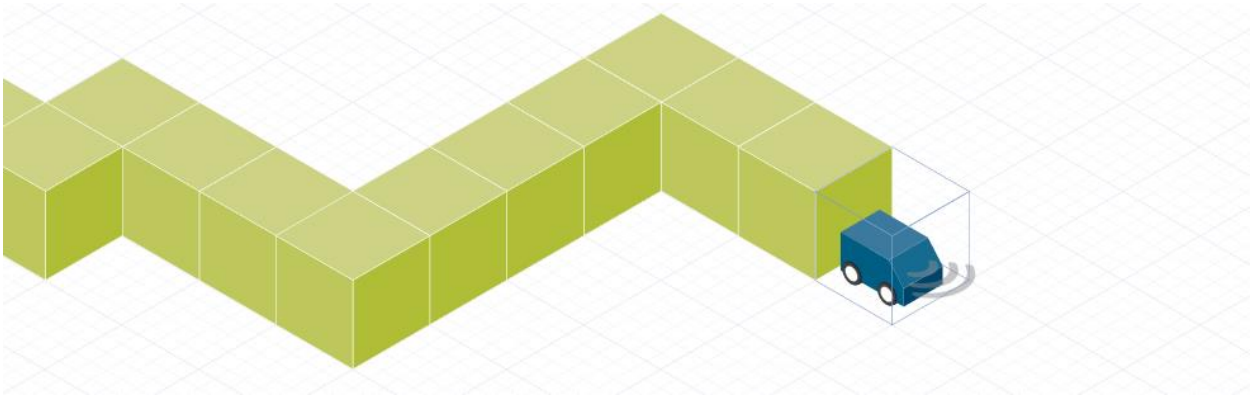


Autonomate: future mobility

Years 9-10

Unit outline

Students will use design thinking to explore technologies used in future transport and mobility.

This unit can be carried out over 2-3 weeks or adjusted to be part of a wider inquiry. Students do not need to complete every task. Teachers can decide how much time to spend on each module.

Activity Description

Students work in teams to research, brainstorm, develop and build ideas for the future of mobility. They will develop a solution and share it with the class.

Teaching Rationale

AutonoMate engages students on the topic of autonomous vehicles as an example of how new technology in the transport sector may change people's lives. Lessons include critical and creative thinking to examine the impacts of this emerging technology.

Running the modules

- Students form into small groups to conduct their inquiry.
- Need device to undertake internet research.
- Option for groups to present to their class as final activity.

Curriculum links

Area	Achievement objective
Social Science Level 5	**Social Studies** • Understand that people move between places and how this has consequences for the people and the places. • Understand how the ideas and actions of people in the past have had a significant impact on people's lives.
English Level 5	**Speaking, Writing, and Presenting** Processes and strategies

	• Students will integrate information, processes and strategies purposefully and confidently to identify, form and express ideas about their solutions and prototypes. Ideas • Select, develop and communicate how they arrived at their solutions. • Use a range of oral, written and visual language features to pitch their ideas. • Use an increasing range of vocabulary to communicate precise meaning.
Technology Level 5	**Computation Thinking for Digital Technologies** Progress Outcome 4 • In authentic contexts and taking account of end-users, students decompose problems to create simple algorithms using the three building blocks of programming: sequence, selection, and iteration. • They implement these algorithms by creating programmes that use inputs, outputs, sequence, basic selection using comparative operators, and iteration. • They debug simple algorithms and programmes by identifying when things go wrong with their instructions and correcting them, and they are able to explain why things went wrong and how they fixed them. **Designing and Developing Digital Outcomes** Progress Outcome 2 • In authentic contexts and taking account of end-users, students make decisions about creating, manipulating, storing, retrieving, sharing, and testing digital content for a specific purpose, given particular parameters, tools and techniques. • They understand that digital devices impact on humans and society and that both the devices and their impact change over time. • Students identify the specific role of components in a simple input-process-output system and how they work together, and they recognise the “control role” that humans have in the system. • They can select from an increasing range of applications and file types to develop outcomes for particular purposes.
Technology Level 5	**Technological Practice** Outcome Development and Evaluation • Analyse their own and others’ outcomes to inform the development of ideas for feasible outcomes. Undertake ongoing functional modelling and evaluation that takes account of key stakeholder feedback and trialling in the physical and social environments. **Nature of Technology** Characteristics of technological outcomes • Understand that technological outcomes are fit for purpose in terms of time and context. Understand the concept of malfunction and how “failure” can inform future outcomes.

Learning Objectives

Students will be able to:

- understand the impact of how people move
- identify the challenges of transporting people across a city or urban setting
- design solutions that take an end-user into account
- understand that technological outcomes are fit for purpose in terms of time and context
- analyse their own and others' outcomes to inform the development of ideas for feasible outcomes
- integrate sources of information, processes and strategies.

In terms of digital technologies, students will be able to:

- write an algorithm (a set of clear and simple instructions that accomplish a task)
- identify when an algorithm produces an error (a bug)
- understand that debugging is the process of removing bugs from our code
- complete the process of debugging:
    - test the algorithm
    - identify the point in your algorithm where a bug occurs
    - fix the bug
- repeat these steps until desired result is achieved
- understand that some algorithms are more efficient than others
- understand that conditionals let us run different code in different situations
- understand the concept of malfunction and how "failure" can inform future outcomes.

Module 1: immersion

The goal of providing students with the topics below is to demonstrate and develop divergent open-ended thinking, given that transport and mobility is a complex challenge.

These are some of the issues impacting us now, what agency do we have to make an impact that positively impacts future generations?

Students form Design and Development teams and assume roles to tackle the challenges.

Learning intentions

- understand the impact of how people move
- identify the challenges of transporting people across a city or urban setting
- understand how the ideas and actions of others impact our lives.

Capturing learning

Expand on this KWHLAQ table to capture students' thinking throughout the immersion phase. They should end up with a page full of questions, ideas and places to launch their inquiries from. Students should be encouraged to come up with as many questions as they can about the various provocations below.

K	W	H	L	A	Q
What do I **know**?	What do I **want** to know?	**How** will I find out?	What have I **learned**?	What **action** will I take?	What **questions** do I have to ask?

Activity 1 – first or last mile

'First Mile Last Mile' refers to the very beginning or end of an individual trip. For example, a student may catch a bus to school, but walk for the last 5 minutes to reach the school gates. This gap between the bus stop and the school gates is referred to as the 'Last Mile'.

Last mile example:

Delivery person (YouTube)

Activity to develop empathy:

Are there activities, duties or jobs at your school that require students to complete a task? (Getting notices, handing in tuck shop money, emptying bins are play time, etc.)

If so, what are the challenges of this for:

- students
- teachers
- parents
- senior leadership.

How were these systems developed at your school? Who decides how it gets done? Who benefits? Who loses out?

Bonus Activity: Students create storyboards of the tasks and jobs they complete around the school, home or the community and are encouraged to think about who and what is involved before and after they take on that task.

Activity 2 – urban transport

Article:

5 Transportation Issues and Challenges Facing US Cities

Activity to develop empathy:

Students use a screen recording of a Google Map in Street View Mode to narrate a time and place where they faced one of the challenges in the article.

Activity 3 – congestion

An outrageous example of congestion (YouTube link)

Activity to develop empathy:

The Orange Game – Routing and Deadlocks (instructional PDF)

Routing and deadlock are problems in many networks, such as road systems, telephone and computer systems. Engineers spend a lot of time figuring out how to solve these problems – and how to design networks that make the problems easier to solve. The aim of this activity is to help your students empathise with this challenge.

The aim of this game is not to "solve" the traffic, but to highlight the complexity.

Activity 4 – transport on demand

Discover articles: Students use 'scooter rideshare' search term on stuff.co.nz to find relevant content:

Stuff search results

Discussion:

- What are the benefits of transport on demand?
- What are the challenges of transport on demand?
- How much does the cost differ from traditional public transport options?

Activity 5 – self-driving cars

Clip: Ethics of Self-Driving Cars (YouTube link)

Discussion: What impact will autonomous vehicles have on…

- safety?
- jobs?
- communities?
- drivers?

Discussion: What problems might autonomous vehicles solve…

Use prompts or personas to get students thinking outside of their own life – i.e. someone who needs to get to hospital, someone who is vision impaired and doesn't have a driver license,

Discussion: What problems might autonomous vehicles create? What will happen to…

- car sales?
- parking?
- learning to drive?

- traffic?

Additional Clip:

The Simple Solution to Traffic (YouTube)

Activity 6 – personal transport experiences

Activity to develop empathy:

Students develop storyboards of their wider transport experiences (bus, train, ferry, driving with whānau vs experience on a school trip, e-scooter).

Students share their storyboards in groups of 3 – 4.

Students highlight the positives and challenges using 'Rose-Bud-Thorn' framework.

Rose – what are the bright spots?

Thorn – what are the pain points?

Bud – what potential is there?

Extra resources

Storyboard

Encourage students to explore a different point of view by picking a character or persona and drawing and making noteson the different steps or stages of an experience.

Create drawing here:	Create drawing here:	Create drawing here:
Explain what's happening here:	Explain what's happening here:	Explain what's happening here:

Module 2: technology immersion

Students have a chance to explore simplified transport technology and discover technology solutions for transport challenges.

This section of the unit is optional, and flexible depending on the hardware and software available to your class. We have included free options, and those that require a lower level of existing technology skills.

Key question

Controlling a vehicle at speed in variable conditions is difficult. Could technology play a role in supporting safer driving?

Learning intentions

- Use computational thinking to develop algorithms, identify bugs and debug.
- Devise and deliver a persuasive argument from a new perspective.
- Link basic technology to real-life applications and outcomes.
- Critically assess the place of ethics in technology.

Activity 1 – learner drivers

Using technology you have available, try to navigate a complex environment with obstacles.

This could involve cars or bots that can be controlled manually via a remote or keyboard.

Or use an online simulator like this one:

City car driving simulator

Discussion

What was easy controlling the car or bot?

What was challenging about controlling the car or bot?

Answers you might be looking for: speed, limited controls, not knowing the course, needing lots of practice.

Did you crash?

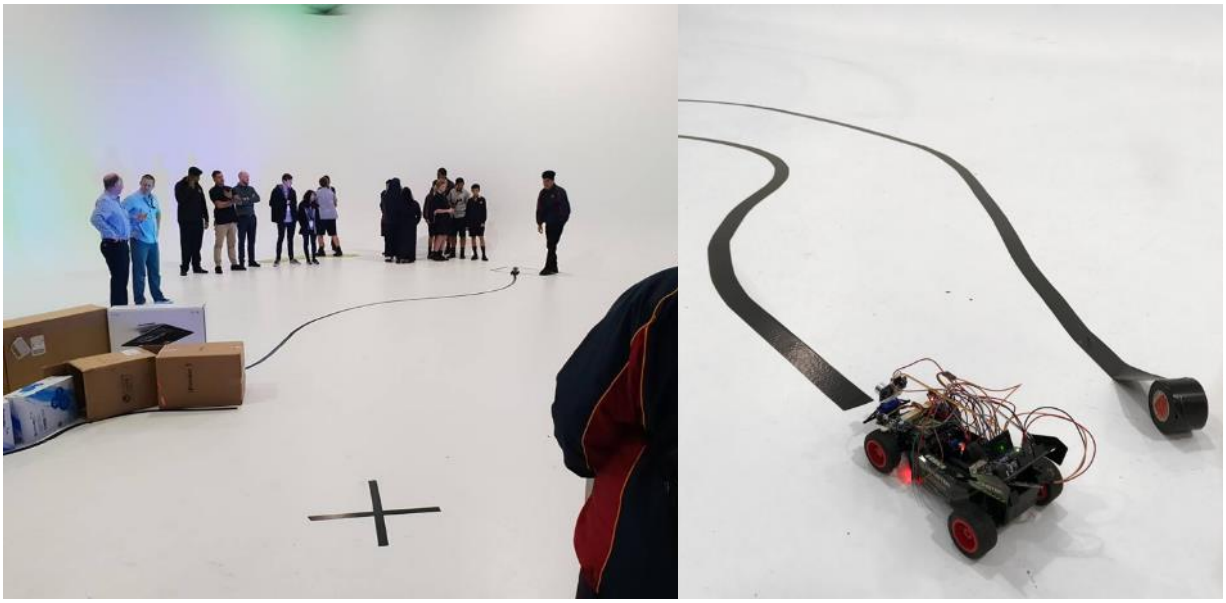
How might those challenges play out on our roads?

Answers you might be looking for: crashes on our roads when people speed, drive unsafely, aren't well trained, don't know the terrain or roads.

Activity 2 – coding to drive

What tools, rules or technology could help us be safer? Students gather into groups and utilise technology to address their identified road safety challenges – you can blend software and hardware here if you wish. There is a list below of resources for hardware-free bot programming. Possible challenges to set in a 'racecourse' or test environment:

- line-following
- obstacle avoidance
- obstacle detection and decision making.



AutonoMate test course – line following, obstacle avoidance.

Discussion

What level of control did you have over the car or bot?

Was it safer?

How might you apply these activities to the challenges:

Answers you might be looking for: line-following = to follow our roads, obstacle avoidance = preventing crashes or cars beeping when reversing / auto-braking, obstacle detection and decision-making = self-driving cars.

When testing your car or bot's ability to navigate the challenges, were they perfect? Would you trust the code to control your car? Why or why not?

Extension

What might this tell us about relying on technology? Potential for discussion about ethics, who writes the decision-making code?

Clip: Trolley Problem – Would you sacrifice one person to save five? (YouTube Link)

Activity 3 – postcards from the future

Individually, students reflect on what life might be like if autonomous vehicles are available and readily used in New Zealand. Encourage them to consider both the positives and negatives from a personal perspective:

- getting to or from school or work
- who they might travel with
- activities and recreation
- getting your license (or not)
- owning a vehicle (or not).

Students are to write a 'postcard from the future'. Get them to imagine they are 10 years into the future and writing to their present day selves to explain what's different and what's the same about their lives, now that autonomous vehicles are accessible in New Zealand.

Extension activity – different lens

Safety is one angle to autonomous vehicles or elements of self-driving car technology, but what other challenges or opportunities might they create? Students form groups and are given a role from the below – they should work in their group to develop a short (2 minute) argument that represents that person's point of view on self-driving cars.

- traffic engineer
- environmental scientist
- doctor
- person who can no longer drive because of poor eyesight
- police officer
- car salesman.

Students are to imagine they are talking to the Prime Minister and a group of politicians deciding if self-driving cars can be used in New Zealand. Each group shares back to the rest of the class.

Resources

Below are some examples of free and paid virtual learning environments for building, coding and simulating robots.

Tier	Resources	Notes
Free and paid options	VEXcode VR	Learn coding with Virtual Robots. Start with blocks and proceed to Python. Ages 8+
Paid	Tekkie Uni	Students code virtual 3D robots using an online learning environment.
Paid	Robotify	3-d browser-based robotics simulator to teach coding in Blockly or Python.
Free Advanced	Gazebo Sim	Gazebo offers the ability to accurately and efficiently simulate populations of robots in complex indoor and outdoor environments.
Paid Advanced	Virtual Robotics Toolkit	Build, programme and simulate your own Lego MINDSTORMS robots.
Free (requires hardware)	Edison Bots	The Edison robot can be programmed using drag-and-drop with EdBlocks, EdScratch or EdPy – great for different learner levels.

Module 3: synthesis & critique

This module is relatively fast-paced. All thinking is made visible. Students are open to new connections while zeroing in on key issues. It encourages them to be empathic, curious to discover underlying problems, critical and open to critique.

When identifying challenges in this module, students should be encouraged to think about their immersion activities and use the storyboards they developed. This can help them decide on points at which an intervention could occur.

Use KWHLAQ to determine next steps in the learning for students. These leap points will generate student interest and accelerate their curiosity.

Key question

What problems worth solving have students identified?

Learning intentions

- Analyse their own and others' outcomes.
- Integrate sources of information, processes and strategies.

Activity 1 – top five

Students gather into groups and write down their personal Top Five challenges, questions, and ideas that jump out at them from the immersion phase and activities.

As students share, they can group similar ideas. This is a great way to form groups again with students who have similar ideas or find their ideas grouped with others.

When it's not a student's turn, get them to pay close attention to what others are sharing. What questions come up? Challenge them to come up with 3 questions each.

Keep the Top Five somewhere in a slide, folder or wall space for each group. This will keep them focused and also allow them to change ideas if an idea is no longer feasible.

Activity 2 – storyboards

Students pick the ONE idea, theme or challenge they want to tackle.

What problem worth solving have the students identified? What are the biggest challenges to overcome?

This is a great way for students to create a plan of where to next with the chosen challenge they want to tackle.

Creating insight statements based on the challenge they chose and what they discovered about it in the immersion phase. Use the "Creative Insight Statements" table.

The following table helps students collect their insights, which they can refer back to when they develop their How Might We questions.

Creative insight statements	
Theme:	1.
	2.
	3.
Theme:	1.
	2.
	3.
Theme:	1.
	2.
	3.

Who is impacted by their challenge? Students pick the characters from their storyboards in Module 1 as the main user they will design a solution for.

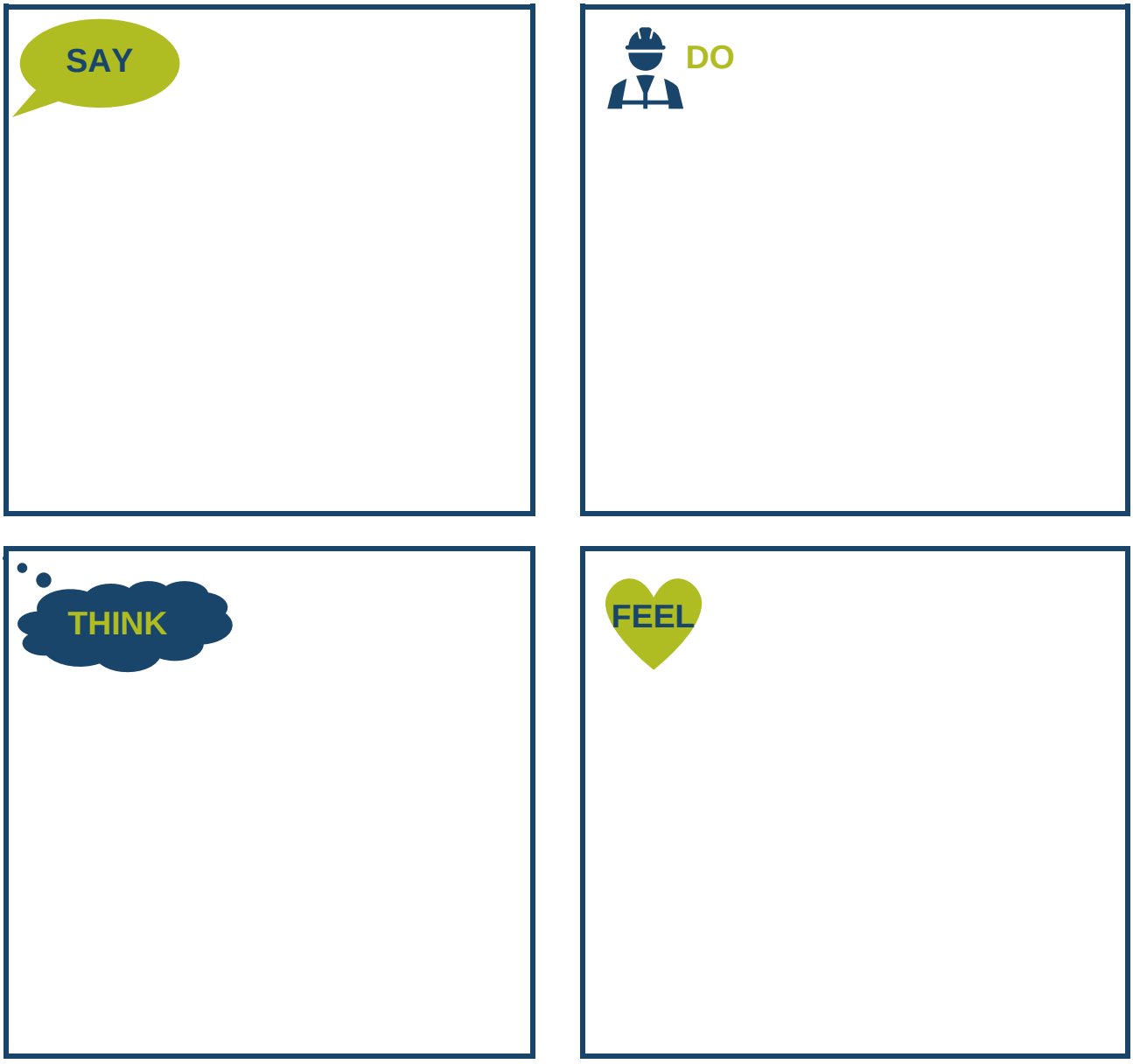
Transport affects people differently. Some provocations or contrasts you could help students think through might be:

- night vs day
- rural vs urban
- younger vs older people
- male vs female
- English speaking vs non-English speaking.

Activity 3 – say, do, think, feel

Students use this activity to explore the range of actions, phrases and emotions their target user might be experiencing. They will take their user's perspective into account when designing their solution.

Are there common themes?



Extension activity – show, don't tell

What do the problems look like? Use any creative means available to you to re-create the challenges that need to be overcome. e.g. Role play, LEGO set, playdough, etc.

Activity 4 – Defining the problem

Create a How Might We statement to take the problem identified and turn it into an opportunity to generate new ideas. The language of a "How Might We…" statement frames a problem as an opportunity and invites students to change their mindset towards generating solutions.

How might we…

How might we…

Insight:

How might we…

Insight:

How might we…

Insight:

How might we…

Insight:

Module 4: ideation

This module is short and fast-paced and encourages divergent thinking. All ideas are welcome, then pared down into separate processes.

Instead of saying, “Yes, but…”, encourage and model saying, “Yes, and…”. This will be hard at first, but practice makes it better. Learning to build on others’ ideas is a key part of developing innovative solutions and mindsets.

Defer judgement! Quantity over quality.

Learning intentions

- Understand that technological outcomes are fit for purpose in terms of time and context.
- Understand the concept of malfunction and how “failure” can inform future outcomes.

Activity 1 – ideation

Using their ‘How Might We’ statements as a yardstick, students are encouraged to generate a range of ideas for the challenge they’re trying to solve.

Students should be encouraged to:

- stand
- borrow ideas from others
- you think it, you write it
- no judgement, you can discuss it later.

Teachers can prompt:

- What’s your worst idea?
- What idea would your mum or dad come up with?
- What if money wasn’t a problem?
- What if you had the help of your favourite superhero?

Aim for 30 ideas in 10 mins! Use prompts above to stimulate tangents and divergent ideas.

Activity 2 – mix and match

Before deciding on the idea they will tackle as a team, students should be encouraged to mix and match ideas to see what new possibilities arise.

Useful tool: the Osborn Checklist, similar to SCAMPER:

- **Put it to other uses?** As it is?... If modified?
- **Substitute?** Different ingredients used? Other material? Other processes? Other places? Other approach? Other tone of voice? Someone else?
- **Combine?** Combine units, purposes, appeals or ideas? A blend, allow, or an ensemble?
- **Adapt?** Is there anything else like this? What does this tell you? Is the past comparable?
- **Modify?** Give it a new angle? Alter the colour, sound, odour, meaning, motion, and shape?
- **Magnify?** Can anything be added – time, frequency, height, length, strength? Can it be duplicated, multiplied or exaggerated?
- **Minify?** Can anything be taken away? Made smaller? Lowered? Shortened? Lightened? Omitted? Broken up?
- **Rearrange?** Swap components? Alter the pattern, sequence or layout? Change the pace or the schedule? Transpose cause and effect?
- **Reverse?** Opposites? Backwards? Reverse roles? Change shoes? Turn tables? Turn other cheek? Transport ‘+/-‘?

Once these extra ideas are added to the brainstorm, each student gets to vote for their 3 favourite ideas. This can be done by initials, shapes or stickers.

Having decided on the idea they will pursue, students can now assume the roles in their group and get ready for prototyping!

Activity 3 – hypothesising

The purpose of prototyping is to test a hypothesis about an idea. Students should work in their groups with the following prompts to develop their hypothesis:

“We believe that [this solution] will enable [this person / group of people] to [accomplish this goal].”

or

“We believe that [target audience] will [do this action/use this solution] to [accomplish this goal].”

Extension activity

Ask students to complete one more prompt: “We will know our hypothesis is right when…”.

Module 5: prototyping & feedforward

Hold ideas lightly. Use short time slots for good constraint. Add in some longer sessions to build quality. Seek regular feedback form peers, users or outsiders.

The purpose of prototyping is for students to test a hypothesis about their idea. This is arguably one of the hardest parts of the project process.

Using low fidelity prototypes will make it easier for them to give feedback to each other. By our own nature, we make judgments. Low fidelity prototypes encourage more honest feedback because they look as though not as much effort has been put into them, so the risk of the hurting the receiver's feelings is minimised.

Show, don't tell.

Learning intentions

- Understand the concept of malfunction and how "failure" can inform future outcomes.
- Students make decisions about creating, manipulating, storing, retrieving, sharing, and testing digital content for a specific purpose – given particular parameters, tools and techniques.

Activity 1 – hypothesising

With their 'How Might We' statements, idea and storyboard in hand, students determine what they think the trickiest part of implementing their idea will be. This will become their hypothesis.

Activity 2 – prototyping

Determining what to prototype.

In their groups, students wrote down the key elements of their idea. Encourage them to think practically about how it might work. Brainstorm some questions for each component of their idea.

Now get the students to pick 2-4 critical questions about their idea.

- If the idea is an interaction, maybe they could roleplay the interaction as a skit.
- If they're testing a logo, print it out and put it on a t-shirt or backpack to solicit feedback.
- If it's an app, use Google Slides and the built-in animations to mock up a core feature.

Students should be made aware of the tools and resources available to them for their prototypes.

Prototyping can fit into a range of tools (see prototyping table below).

Students work as a team to complete their prototypes.

Create opportunities for regular 'Mission Updates'. Regardless of the state and stage of the prototype, getting students to share updates will keep the momentum up and you could even get other groups to feedforward – use 'I like… / I wish… / I wonder…'.

Students could move through the different fidelities of prototyping to gather the most feedback, with the least amount of risk to their end product.

Developing feedforward rounds based on low, mid and high-fidelity prototypes.

Some Guidelines for Prototyping

Just start building. Design Thinking has a bias towards action – that means if you have any uncertainties about what you are trying to achieve, your best bet is to just make something. Creating a prototype will

help you to think about your idea in a concrete manner, and potentially allow you to gain insights into ways you can improve your idea.

Don't spend too much time. Prototyping is all about speed; the longer you spend building your prototype, the more emotionally attached you can get to your idea, thus hampering your ability to objectively judge its merits.

Remember what you're testing for. All prototypes should have a central issue they are testing. Do not lose sight of that issue, but be open to other lessons you could learn through your tests.

Build with the user in mind. Test the prototype against your expected behaviours and user needs. Then, learn from the gaps in expectations and realities, and improve your ideas.

Activity 3 – testing the prototype and the hypothesis

Before deciding on the idea, students should test the belief or assumption that underlies their hypothesis. There are lots of tests your students could design to test their hypothesis:

- interviews with classmates or others in their community
- surveys
- usability testing.

In their groups, students should write down what the experiment should be – referring back to the extension activity above – "We will know we are/our hypothesis is right when…". Define the outcomes that determine whether the hypothesis is valid.

Prototyping table

Low Fidelity	Mid Fidelity	High Fidelity
LEGO or other crafts to make a mock-up Mixing Lego with Design Thinking	Slide with animations (to demonstrate how something digital like an app might work). Here is an example of an idea and prototype for a Running Accountability App.	Robots: Edison, Sphero, MBot.
Post-its If it's an app, you can create a "flick book" of a core feature of the idea. If it's an interaction, create a storyboard and through feedback, swap and change the order of interactions to find what resonates most with users.	Scratch	Website

Module 6: exposition & final feedback

Celebration and public sharing of the final articles of learning, and the journey in building them. This includes:

- final rounds of feedback
- exposition of work
- maybe inviting experts to look at and respond to students work.

Learning intentions

- Select, develop and communicate how groups arrived at their solution.
- Use a range of oral, written and visual language features to pitch their ideas.
- Use an increasing range of vocabulary to communicate precise meaning.

Activities

Creating a Pitch

The first thing students will want to articulate is the essence of their product, service, or experience. Students should offer context, the main thrust of their idea, why it's different from existing alternatives, and any call to action they need from the audience.

How to create a pitch: use these questions to guide students' pitch creation.

- Succinctly, what is your project?
- Who do you need to pitch to?
- What format will your pitch take?
- What's your short pitch? As you write it, think about how you might expand it into a longer one.

The following sentence structure is a great way to quickly shape your elevator pitch. This will help you frame your pitch, which you can then refer back to throughout your project to keep yourself on track.

Formula:

Our **(idea)** help(s) **(this type of customer / person)** who wants to **(jobs to be done)** by **(your own verb, eg. reducing, avoiding & pain point)** and **(your own verb, eg. increasing, enabling + potential gains).**

Example: Using a "Taxi App"

Our Taxi Smartphone App help(s) taxi passengers who want to book a taxi by minimising wait time for a taxi and enjoying affordable prices.

Copy as many times as needed and trial different combinations.

Presentation

Celebrate! Brainstorm with students for ideas on how they would like to celebrate their learning.

Students determine the best way to present their work.

- skit and playing out the scenario
- demonstration – their robot completes a challenge related to the problem they are tackling
- slide or PowerPoint – students pitch their solution to the class and invited guests
- posters or campaign
- video advertisement that sells their solution.

Create an expo, a space and place for students to present their pitches. Invite Waka Kotahi or local council staff to your school!

Assessment Rubric

Key Competencies and Values		1 Basic understanding	2	3 Great understanding	4	5 Exceptional
Respect Yourself	Thinking	I struggled to come up with ideas.	I came up with some original ideas but mostly relied on others.	I came up with ideas and was inspired by some research I did.	I found relevant sources of inspiration.	I came up with lots of ideas and got outside my comfort zone.
	Using Language, Symbols and Text	Didn't use any research to develop my idea.		Used some research when developing my idea further.		I used lots of research so I could develop my idea and make it better.
	Managing Self	Wasted a lot of allocated time.	Needed reminders to stay on task.	On task most of the time, task completed in given timeframe.	"I need to focus on my work and stay on task at all times" …	
	Design	I didn't put enough thought into my original plan.	I needed a lot of prompting and support to complete my planning.	I planned my final product.	I planned my work in detail including notes on style/colour and composition.	My final product shows lots of in depth thought and creativity/attention to detail.
Respect Others	Participating and Contributing / Relating to Others	I needed reminding about my part in the group and how to communicate with others.	To work without making noise so other people can work without getting off task. Share some ideas with the group.	Understand how exploration and innovation create opportunities and challenges for people, places, and environments.		Developed a solution with my team.