Representing images using binary: totems

Years 5–6

In this lesson, students will interpret a First Nations Australian artwork by representing an image they create as a binary image with accompanying code.

Language note

We have chosen to use the terms ‘Aboriginal and Torres Strait Islander’ and ‘First Nations Australian’ throughout this resource to align with the language used in version 9.0 of the Australian Curriculum. We also use ‘First Nations Traditional Owners’ as this is Tania Taylor’s preference. We acknowledge that this may not be the preferred term for the First Nations Peoples where your school resides. Educators and leaders are encouraged to engage with First Nations Traditional Owners of the land you reside on to clarify preferred language.

About the authors

Tania Taylor

Tania Taylor is a proud Kaurna, Narrunga and Ngadjuri woman with nearly 20 years experience in community development and engagement, mentoring, education support, program design and strategic planning. She has served her community as an active board member of the Kaurna Yerta Aboriginal Corporation for eight years. Tania’s knowledge and experience includes working with Aboriginal communities in metropolitan, in a range of settings level across Australia.

Kim Martin

Kim Martin is an accomplished educator, with expertise in inclusive learning technologies. She has held various teaching and leadership roles in the education sector, non-profit organisations and education technology companies across South Australia. Kim's commitment to education through technology is exemplified by her accolades, including 2014 ACCE Educator of the Year, and recent recognition as the 2023 EdTechSA Leader of the Year. Her passion lies in harnessing technology to facilitate differentiated learning experiences enabling learners to demonstrate their knowledge and understanding. Kim is a non-Aboriginal collaborator.

Why this is relevant

It is important to understand how data is stored and share in digital systems. Imagine data as different types of things, like pictures, sounds, numbers and words. In a digital system such as a computer, these different types of data are coded in a special language made up of ones and zeros, kind of like a secret code. This code acts as a series of tiny switches that can either be turned on or off. When the code is transmitted in the computer, it's like sending a message using electrical signals that are either there (on) or not there (off).

Imagine a picture like a big puzzle or intricate mosaic made up of tiny dots called pixels. Each pixel is like a little dot that can be a different colour. To help the computer understand and remember all the colours in a picture and their location, it uses a special language called binary. Binary is a code made up of ones and zeros. When you want to save a picture, it represents each pixel as a binary number, which

is a long string of ones and zeros. This way, the computer can keep track of what to do for each pixel and recreate the picture accurately so that the image looks like something you recognise. Pixels can be simple – (one bit per pixel) just two values on or off, such as black or white. A coloured pixel has more information (8 bits per pixel) which is a combination of Red, Blue and Green (RGB).

Engaging with Aboriginal and Torres Strait Islander communities

Protocols for engaging with Aboriginal and Torres Strait Islander communities

Consider inviting an Aboriginal or Torres Strait Islander community member to your class. They can share insights and experiences of travelling to visit family on Country from their perspective. When approaching community members, including Elders, please be mindful that not all possess knowledge relevant to your learning outcomes. As individuals, just like everyone else, they have diverse specialties and interests. It cannot be assumed that they have the authorisation or a willingness to share their knowledge.

In the learning environment, fostering positive experiences with Aboriginal Peoples and Torres Strait Islander Peoples is crucial for promoting attitudinal change and building respectful relationships. Inviting active involvement of Aboriginal and Torres Strait Islander Peoples in all stages of your program development by employing them as guides and experts, not just guest speakers, can provide valuable learning experiences that enrich your and students' knowledge and awareness beyond the individual lesson shared here. Before you invite guests from Aboriginal or Torres Strait Islander communities to your school, first seek out information about proffered protocols for engaging with Aboriginal or Torres Strait Islander Peoples on your Country. Local government websites often have guiding information to help you. Common considerations include the negotiation of dates, time and duration, and payment rates well in advance, and ensuring that the visitor has transport arrangements.

We recommend referring to your state or territory education governing body for context and guidelines regarding culturally respectful practices. Here are a few links to get your started.

SBS: Aboriginal and Torres Strait Islander Protocols Guide – for Teachers
https://www.sbs.com.au/learn/resources/aboriginal-and-torres-strait-islander-protocols-guide-for-teachers/teacher-resource/

Culture is Life: Teaching First Nations Knowledges & Perspectives
https://cultureislife.org/education/resources/teaching-first-nations-knowledges-perspectives/

Beyond Blue | Be You: Culturally respectful engagement for learning communities
https://beyou.edu.au/resources/culturally-respectful-engagement-for-learning-communities

Cultural safety

Every child has a right to feel safe at school. Creating safe conditions for learning involves providing supported yet challenging environments to enable high-quality learning opportunities. Cultural safety, defined in Williams (1999) as an environment that is spiritually, socially and emotionally secure, is crucial. It encompasses shared respect, meaning and knowledge; and the experience of learning together with dignity. In classrooms, recognising the diverse life experiences and knowledges of Aboriginal and Torres Strait Islander children is essential, acknowledging that each student's connection to and understanding of their histories and cultures varies. Caution is advised when requesting students to share information, as they may not possess the knowledge, permission or

comfort to do so, causing cultural load for the student. In interactions involving First Nation Australian historical and cultural contexts, establish ground rules for respectful discussions and behaviours, considering the complexity and sensitivity of each student's identity and cultural connection.

Reference
Williams, R. (1999). Cultural safety: What does it mean for our work practice? *Australian and New Zealand Journal of Public Health*, 23(2), 213–214. https://doi.org/10.1111/j.1467-842X.1999.tb01240.x

Indigenous Cultural and Intellectual Property

'Indigenous Cultural and Intellectual Property [ICIP] refers to the rights that Indigenous people have, and want to have, to protect their traditional arts and culture' (Arts Law Centre of Australia).

The lesson ideas and discussion prompts are designed to support teachers in facilitating learning opportunities that help students' understanding of First Nation Australian ways of knowledge and perspectives within the curriculum area of Technologies, specifically the Digital Technologies subject. We see many opportunities for integrated learning across all learning areas including English, Mathematics, Arts, and Humanities and Social Sciences (HASS).

Learn more: ICIP information sheet

Learning hook

Refer to the slides: Data representation: Totems and pixel art.

- View the SBS program, *The First Inventors,* Episode 3, story 5, which is about totems (time code 35:50; duration about 10 min). This can be done as a class or as part of a flipped learning experience.
- Discuss as a class what new information was in the story for you. Was there anything you already knew or a piece of information that changed your mind about the way you think about the significance of totems for First Nations Australians?
- Discuss how the class might start to relate to this concept by discussing their favourite animal and how they could protect it from harm. What considerations would be needed to keep the animal and the environment they need to survive safe?
- If possible, invite an Elder from the Aboriginal and Torres Strait Islander Nation your school is situated on. Ask them to share their connection to totems. (This may incur a fee.)

Learning map and outcomes

Learning intentions

Students will:

- explore how to create a set of binary code instructions so that a friend can reproduce the image they have created
- develop their understanding about First Nations Australians' connection to Country, the environment and animals, and their sense of responsibility to care for them
- build on their knowledge of binary numbers, beyond 0's and 1's, by starting to introduce colour.

Success criteria

Students can:

- create their own image by encoding a grid using binary digits
- decode a classmate's encoded grid to produce an image
- explain what a binary number is and how this can be displayed as an image.

Learning input

- View a video about pixels, binary and how a computer creates an image on a screen. For example, the video A little BIT about Pixels (6 min) by Code.org that covers images, pixels and RGB (colour).
- Look at the images created by First Nations Australian artist Tania Taylor. See the stages her designs went through to get to the end product: hand-drawn sketch, graphic designed on computer, image cut out of metal, and metal creation installed as part of a public art installation.
- Compare the artist's designs to the finished product: Is there more or less detail in the final image?
- Discuss if it would be possible for you to create a drawing in Minecraft with enough detail that a friend would know what it is. (If your school has a Minecraft Education software licence, you could ask students to recreate their Australian animal in Minecraft and then write the code instructions for a friend on graph paper or using a spreadsheet program so they can recreate the image you created.)
- Teacher models a drawing and how to add the binary instructions, modelling one line of binary code per equivalent line of the drawing so students can more easily see how the numbers correspond to the drawing.
- Students explore this code.org colour pixelation freeplay widget for more opportunities to practise and learn about binary and pixel art.

Learning construction

- Lead students to think about totems and ask them to research an animal that either currently lives on Country where the school is situated or lived there a long time ago. Ask students to list of what kind of environment that animal needs to not only survive but thrive and what, if any, changes would need to be made to your local environment to facilitate this.
- Students choose an Australian animal that they will create in the style of pixel art using graph paper and binary numbers.
- Explain that they will need several attempts and iterations, just like the artist Tania's process, before they get to the final finished piece that they are happy with.
- Ask students to think about the simplest way to represent their chosen animal as an image. For example, if I draw a square with a triangle on the top and a rectangle in the middle of the square, most people recognise this as a house, despite little detail in the image.

  Step 1: Students attempt the pre-designed pixel art worksheet Pixel art: practise with Tania Taylor's turtle to recreate a turtle drawn by Tania Taylor as a pixel image.

  Step 2: Using graph paper or a spreadsheet application, students create their pixel art of their chosen animal using black (0) only, with spaces not part of the drawing left white (1).

  Step 3: Students attempt to write the binary code for their image.

Learning demo

- Students share their first design with a peer and ask them to test the instructions and give feedback, sharing the code only as the instructions and a piece of graph paper for the friend to recreate the image.
- Students make improvements to their design based on feedback from peers.
- Students share their pixel art with family and include information about why the animal is special to them and what they have learned about totems and kinship as well as binary code and pixel images.
- If your class has access to Minecraft Education, students can create their pixel art in a shared class world. Set up clear guidelines and expectations before starting this task. For example, design constraints such as size and time, and behaviour expectations such as respecting other students' design space and not demolishing or changing it.

Learning reflection

- Share instructions (binary code only) for your image with a friend so that they can try recreating the image.
- Discuss what students found easy to understand and more challenging about pixel art and how computers use binary to store information about images. For example, was the inclusion of colour with RGB harder to understand than black and white image representation?

Teacher cultural competencies

- It is important to uphold the importance and significance of totems and kinship for First Nations Australians (rather than having just a quick conversation and comparing totems to a student's favourite animal). Students need to be made aware of the deep connection and responsibility a First Nations Australian has to their totem.
- In this lesson we are not asking students to recreate art by copying the First Nations Australian artist's work. If students were creating art with the purpose of recreating Tania's work this would likely be considered appropriation and the ICIP belongs to Tania. We are asking students to create their own contemporary art piece in the style of pixel art, using their new knowledge about totems to think deeper about First Nations Australians' connections to their kin and totems.
- To develop a reciprocal and respectful relationship with the Elders of the Country your school is situated on, it is imperative that they are remunerated appropriately for their time and willingness to share their knowledge and expertise with you. Make sure you have a conversation about your expectations and the learning your class are hoping the Elder can add value to by sharing their knowledge and stories with your class.
- We encourage a two-way capacity-building collaborative approach when working with First Nations Traditional Owners. Engage with them as early as possible when you are planning learning experiences to discuss lesson focus and goals. Explain the structure of the lesson you would like their input and collaboration on. Develop a reciprocal relationship that includes discussing cultural considerations and sensitivity and how these fit with the structure of content being taught before they visit your classroom. Sharing in the planning will provide opportunities to increase the value of the learning experience for the teacher, students and guest speaker.

Differentiation

- Investigate what native animals live or lived on Country where you live, play and learn.

- Spend time learning about one animal from your Country that lives there now or used to live there. What environmental conditions does it need to thrive?
- For students not ready for pixel art, allow them to practise with colour-by-number type experiences.

Resources

Graph paper or access to a tablet or computer with spreadsheet software such as Excel or Numbers for iPad.

Slides: Data representation: totems and pixel art

Worksheet: Pixel art: practise with Tania Taylor's turtle (print or provide electronically) – includes turtle designed by Tania Taylor.

Code.org: Images, pixels and RGB video (6 min)
https://www.youtube.com/watch?v=15aqFQQVBWU

Code.org: Colour pixelation freeplay tutorial
https://studio.code.org/s/pixelation/lessons/5/levels/1

Code.org: Intro to pixelation encoding B&W (3 min)
https://www.youtube.com/watch?v=rJOa5Q5a1WM

Come Together: things every Aussie kid should know about the First Peoples by Isaiah Firebrace with illustrations by Jaelyn Biumaiwai. This story has one page dedicated to totems. If your school has a Story Box Library subscription you can access a reading by the author, Isaiah Firebrace, a proud Yorta Yorta and Gunditjmara man. https://storyboxlibrary.com.au/stories/come-together-things-every-aussie-kid-should-know-about-the-first-peoples

Cool.org: Telling your story with digital art (emojis)
https://cool.org/lessons/telling-your-story-with-digital-art-emojis-year-5-6-design-and-technology

SBS: *The First Inventors*, Episode 3: A connected continent, story 5: totems (part of the Moiety system)
https://www.sbs.com.au/ondemand/watch/2225052227769

The First Inventors, Episode 3: A connected continent, story 5 teaching resource by Shelley Ware
https://drupal.prod.sbs.com.au/sites/sbs.com.au.home/files/first_inventors_2023_ep_3_story_5.pdf

The Mark of the Wagarl by Lorna Little with illustrations by Janice Lyndon (picture book)
https://magabala.com/products/the-mark-of-the-wagarl-revised-edition#

Reconciliation Australia: Family and kinship video (1 min)
https://www.youtube.com/watch?v=mNtPcW4t1PY&t=1s

Watarrka Foundation: Role of family and kinship in Aboriginal culture
https://www.watarrkafoundation.org.au/blog/the-role-of-family-kinship-in-aboriginal-culture

Australian Curriculum

Digital Technologies

Achievement standard

By the end of Year 6, students process data and show how digital systems represent data.

Content descriptions

Years 5–6

- Explore how data can be represented by off and on states (zeros and ones in binary) (AC9TDI6K04)
- Explain how digital systems represent all data using numbers (AC9TDI6K03)

Related content

Mathematics

Year 5

- Acquire, validate and represent data for nominal and ordinal categorical and discrete numerical variables, to address a question of interest or purpose using software including spreadsheets; discuss and report on data distributions in terms of highest frequency (mode) and shape, in the context of the data (AC9M5ST01)

Mathematics

Year 6

- Recognise situations, including financial contexts, that use integers; locate and represent integers on a number line and as coordinates on the Cartesian plane (AC9M6N01)
- Interpret and compare data sets for ordinal and nominal categorical, discrete and continuous numerical variables using comparative displays or visualisations and digital tools; compare distributions in terms of mode, range and shape (AC9M6ST01)

Cross-curriculum priorities

Aboriginal and Torres Strait Islander Histories and Cultures: Culture

First Nations Australian societies are diverse and have distinct cultural expressions such as language, customs and beliefs. As First Nations Peoples of Australia they have the right to maintain, control, protect and develop their cultural expressions, while also maintaining the right to control, protect and develop culture as Indigenous Cultural and Intellectual Property. (A_TSIC1)