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The journal for educators

Teaching poetry

Animality in fiction

Scientific knowledge through argumentation



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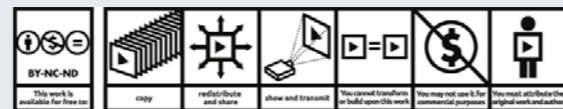
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PEER REVIEWED RESEARCH

Enriching the teaching of English through poetry



Dr Lorraine (Lorri) Beveridge

Curriculum Advisor,
NSW Department of
Education

In this case study, Dr Lorri Beveridge outlines her involvement in guiding a primary school in the teaching of poetry across all stages of learning from K-6 and shares her stimulating ideas and resources.

'Promise me you'll read all the poetry books on the shelf by the front door... Promise me you will make your life graceful ... Promise me you'll make your life grand and beautiful and poetic, and even if it's not poetic, you'll write it like it is.'
(Trent Dalton, 2020)

The rationale for this paper is to encourage teachers to enrich classroom English through incorporating more poetry, 'the rhythmical creation of beauty in words' (Edgar Allan Poe).

What is poetry?

Poetry is a literary form that sits somewhere between oracy and writing. Its primary role is to humanise by sharing inner thoughts

and feelings. Poetry is a useful writing tool to articulate and make sense of what is meaningful in life. Although ubiquitous, it is not necessary to share poetry unless the poet is inclined to do so. However, according to June Jordan (1989) and Adrienne Rich (1988), poetry belongs to the people, not to be judged by how one rhymes or recites words, but 'how well one arranges words on a page to produce meaningful, political, and personally urgent music' (Kinloch, 1996, p 96). Words are given intensity through focusing on the aesthetic and rhythmic qualities of language. Definitions of poetry are often varied and provided as broad-brush statements, but put simply:

Poetry is a type of literature, or artistic writing that attempts to stir a reader's imagination or emotions. The poet does this by carefully choosing and arranging language for its meaning, sound, and rhythm.
(Britannica Kids, 2020)

Celebrated poet Edgar Allan Poe, who penned the renowned poem '[The Raven](#)' (1849), a melancholy lyric of lost love, shares a similar sentiment in his comment, 'Poetry is rhythmical creation of beauty in words' (Willis and Lowell, 1856). Poetry stirs the soul and yet takes many forms which is possibly why it is so difficult to define. When popular British children's author and poet, Michael Rosen, approached the tricky question of 'What is poetry?' he considered the question to be too complex to warrant a straightforward response. Rosen instead framed the question as 'What can poetry do?' He concluded that poetry suggests things and build images in the reader's mind. Poetry can play with words. Poetry is rich in imagery and figurative devices. Poetry can be deeply personal, capturing special and magical moments in words that evoke strong feelings both in the writer, and the reader (Rosen and Calder, 2017).

John Hegley (2018) wrote a poem for children titled, '[What a Poem is Not](#)', stating in an abstract and humorous way that poetry can take on limitless forms. Also, poems usually contain poetic devices, for example, alliteration, assonance, use of figurative devices, rhyme and rhythm. Such devices add depth and feeling to words, making words 'sing'.

Syllabus links

English is enriched by the inclusion of poetry and all syllabus objectives are evidenced in the teaching of poetry. In studying poetry, students learn to communicate through speaking, listening, reading, writing, and viewing and representing. Poetry requires students to use language in creating their own poems. They learn about how language works by experiencing the poetry of others. It is a creative pursuit, necessitating readers and writers to think imaginatively and creatively about topics when responding to and composing poetry. Students learn to express themselves through reading and writing poetry, which assists them to make sense of their relationships and their world. Finally, by reflecting on their own poems and the poetry of others, students gain insights into how we come to know things and why things exist in our world, fostering further learning.

Poetry blitz – a whole school focus

As a NSW Department of Education curriculum advisor, I was invited to assist a school with implementing a poetry study across the school. The following case study details this particular school's focus on poetry across all learning stages of English, delivered during the final term of the year. Poetry was targeted by the staff because Term 4 is traditionally one with many interruptions and teachers felt that completing a novel study at this point in the year may not be achievable due to a lack of time. Teachers wished to continue their shared K-6 English focus across the school, which had been working well throughout 2020. In terms of context, the school is a coastal holiday village, 50km north of a major centre. There are 158 students in the school, and 27% of the students identify as of Aboriginal descent.

During Term 4, teachers of the different stages of learning concentrated on various aspects of poetry. For instance, Early Stage 1 teachers focused on free form poetry, drawing on the grammatical knowledge they had been building throughout the year. The grammar focus was supported by intensive professional learning on how language works. This took the form of fortnightly staff meetings at which I, as a consultant, led the staff in interrogating student learning needs evidenced by writing samples and NAPLAN data. During the staff meetings, we collaboratively discussed how best to address identified student learning needs, building on prior learning. Teachers completed tasks between sessions, embedding new learning in their classrooms, which they reflected on and refined during staff meetings. The theoretical underpinning of the professional learning was based on the widely accepted view that collaborative professional learning positively influences student achievement and builds teacher collective efficacy (CESE, 2020; Hattie, 2015; AITLS, 2012).

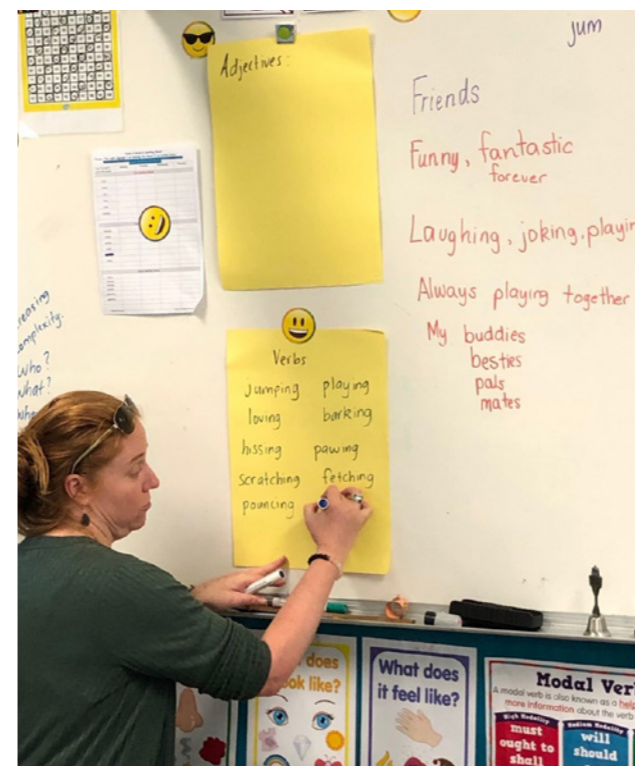
Successful change in schools requires supportive leadership (Beveridge, 2014, p 104) and the Principal contributed to the building of a collaborative learning culture, through facilitating a whole school approach to professional learning. He was an active participant and, along with the school executive, monitored the way professional learning targeted improvements to classroom practice. The executive ensured that student learning was the sustained focus across the school. The school purchased copies of 'A New Grammar Companion for Teachers' by Beverly Derewianka, a resource to guide the teaching of grammar functionally and in context, an area of identified need in the school. Alongside the [NSW English K-10 syllabus](#) and [National Literacy Learning Progression](#) (ACARA, 2020), these documents formed the basis of professional learning discussions, and were authoritative sources that guided classroom practice.

In Early Stage 1 (ES1), teachers and students identified poetic form across a range of familiar quality texts and big books. Students identified rhyme, rhythm, alliteration, and assonance in these texts. Through deep discussions about texts, we noticed their codes and conventions in context, in particular the overarching structure of a poem, including how it looks on the page, its punctuation and layout. The lesson plan for the [Kinder poetry demonstration lesson](#) is accessible from this link. The related writing activity involved modelled, guided and independent writing of free form poetry about animals based on the text, 'Getting Water' by Jo Windsor (2003). This particular text was chosen because it linked to prior learning about how language works, emphasising the recursive nature of language learning through the explicit teaching of, and engagement with, a range of increasingly diverse range of texts ([NSW English K-10 syllabus](#)). In the ES1 classroom, I modelled the writing of free form poetry for teachers, then teachers completed a similar activity with their students. A vignette of the class teacher modelling the activity outlined in the lesson plan is provided as evidence of changed teacher practice. A student writing sample is also provided to show student achievement of success criteria as outlined in the lesson plan. [Teacher modelling](#) (0:18) of the writing activity and student [work samples](#) (0:10) are available as videos.



Teachers share their favourite poems with Stages 1 and 2 (1:15)

In the Stages 1 and 2 classrooms, teachers introduced students to different types of poetry. We shared [teachers' favourite poems](#) (1:15) with the class. These were delivered with gusto and enthusiasm, demonstrating to the students that their teachers valued sharing and performing poetry. Students were reading and writing limericks, haiku, and acrostics during class English activities, enjoying the rhyme and the rhythm of the language and the rich imagery and figurative language that is a hallmark of this literary form.



Creating word banks together to support independent poetry writing.

In addition, I compiled a poetry booklet of favourite poems throughout the ages, [Having Fun with Words](#), which teachers used with their students throughout the term, immersing them in experiencing and creating a range of types of poems. On reflection, we found writing cinquains ('Having Fun with Words' pp 6-7) to be too challenging for Stage 1 students and concluded that this task is possibly more suited to Stage 2 students and above.

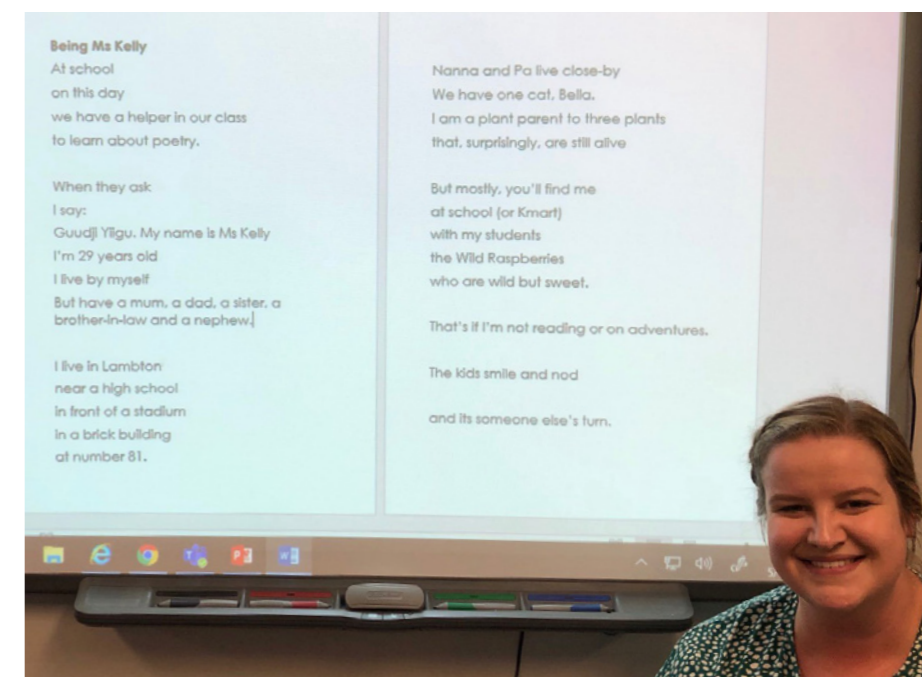
Getting students to engage with writing cinquains was challenging - like pulling teeth. Many [students] required lots of scaffolding and support to complete the writing task.
Erin, Stage 1-2 teacher

We also found that creating word banks with students on topics they wished to write about was supportive of their successful completion of writing cinquains, and poetry more broadly.

The class reported that they enjoyed hearing and feeling the rhyme and rhythm of the poetry. We used musical instruments to emphasise the beat of the words as we put poetry to song, using samples from the poetry booklet, 'Having Fun with Words'

During class reflection time, at the conclusion of the Stage 1 and Stage 2 demonstration lessons, students reported that they learned that some forms of poetry adhere to very specific rules about length, rhyme and rhythm, but that poetic form can vary extensively across different types of poems. An aspect of reflection mentioned by many students can be summarised as '... poems do not have to rhyme but oftentimes, they do!' (Stages 1 and 2 student feedback).

As with Stages 1 and 2, students in Stage 3 were also investigating poetic form through exposure to a range of types of poetry. I sought teacher feedback on a draft unit I was co-writing with the local Aboriginal Education Team. The main focus text for the unit was a junior verse novel. Teachers were keen to trial some of the poetry activities in the unit. Also, the school was dedicated to including more authentic Aboriginal cultural content in class English lessons, to increase student engagement and build Aboriginal cultural pride in all students. Teachers aimed to increase the



Stage 3 teachers modelled texts based on their own innovations of an extract from 'Bindi'.



Stage 3 teachers modelled texts based on their own innovations of an extract from 'Bindi'.

Being Ms Dunford
 Original, my name is Ms Dunford
 I'm 34 years old
 I live near the beach
 In Merewether
 I live in a small townhouse
 With some friends
 We have a front deck
 With palm trees
 In the summertime,
 We like to have
 barbeques on the deck
 I love the smell of sausages
 And the salty sea air
 Most nights you'll find me
 Walking along the sand

proportion of Aboriginal students in the top two NAPLAN bands, in line with a wider Department of Education strategic focus relating to excellence and equity ([NSW Department of Education: Strategic Plan 2018-2022](#)).

We composed innovations on a section of the text, 'Bindi' by Kirli Saunders (2020). This was a modelled, guided and independent reading and writing activity. The [lesson plan](#) is available via this link. Stage 3 teachers modelled their own texts created during the lessons.

High student engagement was evident in the quality of free form poetry that was produced. Students demonstrated their knowledge of

a range of poetic devices in their poems, including imagery, personification, and other examples of figurative language. One Stage 3 student orally shared her poem, [About Me](#) (0:49), demonstrating attainment of stated success criteria. Another student revealed that learning about poetry in class English lessons had provided her with a vehicle to share her inner thoughts and feelings, positively influencing her emotional state. This student composed and shared a free form poem called [Dreams](#) (0:46). The poem outlines the whirlwind of emotions she is experiencing as she approaches the challenging time that is adolescence. The student reported that writing and sharing poetry helps her to make sense of an uncertain world.

On reflection

Poetry is fun, engaging for teachers and students alike and filled with a variety of style, topic and language choices. Poetry provides multiple opportunities for students (and teachers) to share their work orally and in written form in class, across the school and more widely using digital platforms. Although it may be challenging to pinpoint exactly what poetry is, we have outlined that this literary form sits somewhere between the oral and written mode and is well referenced in all grades in the English syllabus.

Poetry is fundamental in the development of children's reading and writing. Regularly engaging students with a deliciously diverse diet of poetry, provides opportunities for them to make connections between the language choices poets make and how these language choices impact meaning. In turn, students can draw on this knowledge to strengthen their own reading and writing.

Poetry in its oral form, is thought to predate writing as it was a means of orally passing on information before humans could write. Thus, poetry is important to humankind due to its high cultural significance (Gunmere, 2019; Pound, 1917). By raising the status of poetry in classrooms, students are provided with a language to read, write and talk about their innermost feelings, hopes and dreams for the future, thereby making better sense of their world. Reading, writing and sharing poetry helps to articulate the feelings and sensitivities of life.

**The poet waits quietly
 To paint the unsaid.
 Atticus (2020).**

Teaching poetry in the study of English, 'shapes our understanding of ourselves and our world, is challenging and enjoyable and builds a love of literature' ([NSW English K-10 syllabus](#)).

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'An ANZAC Tale' by Ruth Starke and Greg Holfeld (2013, Working Title Press)

students to think deeply about animality in fiction. By focusing on 'Migrants', a wordless picture book by Issa Watanabe, questions will be raised about how the incidence of metaphorical animals may be approached in the classroom.

Anthropomorphism and zoomorphism

In the context of art and literature, 'anthropomorphism' refers to the practice of attributing human qualities to animals. It is evident in many books for children, including classics such as 'Alice's Adventures in Wonderland' by Lewis Carroll, 'Wind in the Willows' by Kenneth Grahame, Beatrix Potter's tales, 'Charlotte's Web' by EB White and a vast array of recent publications that host talking animals.

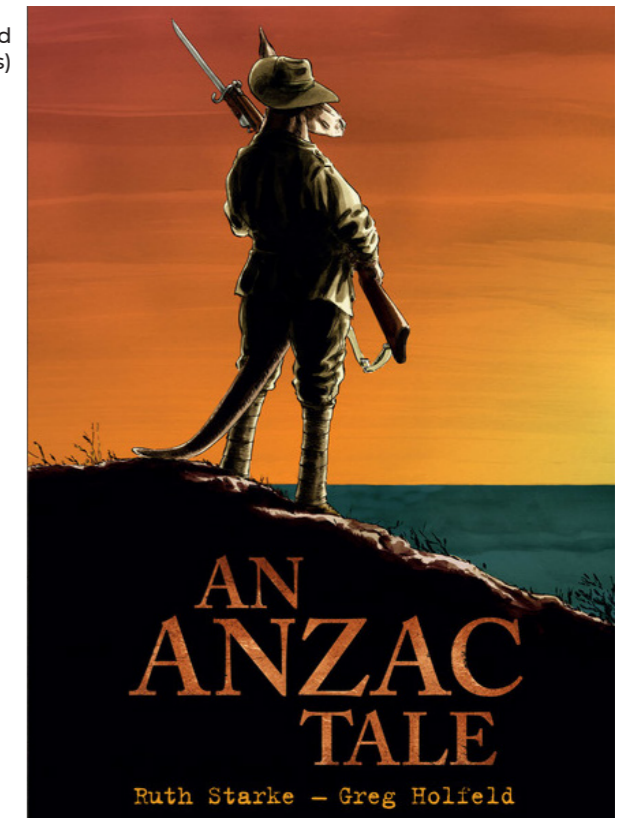
A less frequently used device is 'zoomorphism' which involves ascribing animal forms or characteristics to humans, observable in popular comic book characters such as Spiderman, Batman or Wolverine. Characters in George Orwell's 'Animal Farm', an allegory of the political players in the Russian Revolution can also be described as zoomorphic, as can the drawn characters of Art Spiegelman's highly acclaimed Holocaust graphic memoir, 'Maus'; and in a recount of the battle for Gallipoli during World War I, 'An ANZAC Tale' by Ruth Starke and Greg Holfeld. As teachers will be aware, there is an abundance of books which include animal-human or human-animal characters.

'Anthropomorphism' refers to the practice of attributing human qualities to animals...

'Zoomorphism' involves ascribing animal forms or characteristics to humans.

Interpreting animality in fiction

There are several reasons why this metaphorical use of animals is both perceptive and popular. Animal characters help to diminish the didactic nature of stories that provide moral lessons for humans, as is the case in the oft revisited tales from antiquity, known as Aesop's Fables. In these tales, animals

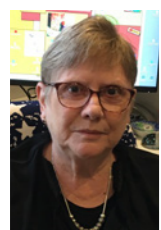


operate as markers of good or bad qualities to be found in humans and present moral lessons in a generalised, more palatable way. Animals are also used to mask or disguise humans who are the focus of satirical comment, as is evident in Orwell's 'Animal Farm'. Animal characters also tend to dissipate traits such as gender, age, class and ethnicity, allowing a story to have relevance and appeal to a more pluralistic audience.

The metaphorical use of animals is a powerful rhetorical tool, and one that should not be overlooked. Contemporary theorists, particularly those working in the fields of animal studies, ecocriticism and postmodernism, display a growing interest in animal characters in literature. Books and articles such as 'Picturing the Beast' (2001) by Steve Baker; 'The Animal Fable in Science Fiction and Fantasy' (2010) by Bruce Shaw; 'Speaking for Animals' (2012) edited by Margo DeMello; 'The Speaking Animal: Nonhuman Voices in Comics' (2012) by Lisa Brown; and 'Toward a Zoonarratology: Storytelling and Species Difference in Animal Comics' (2012) by David Herman, indicate the diversity and contention within this area of interest.

In brief, opinions shift between a positive appreciation of the bonds between humans and nonhuman animals and, conversely, an uneasiness that

Anthropomorphic or zoomorphic? – Fictional animals



Dr Cathy Sly
Researcher and writer

Dr Cathy Sly explores the difference between the literary devices of 'anthropomorphism' and 'zoomorphism', and suggests ways to encourage students to think deeply about animality in fiction.

A multitude of talking animals inhabit fiction for readers of all ages, from preschool children through to adults. As Lorraine Daston and Gregg Mitman (2005) note, 'humans assume a community of thought and feeling between themselves and a surprisingly wide array of animals; they also recruit animals to symbolize, dramatize, and illuminate aspects of their own experience and fantasies' (p 2). Given the profusion of human-animal characters in literature for children and young adults, it is worth considering what they contribute to the meaning making process. This article investigates the difference between literary devices known as 'anthropomorphism' and 'zoomorphism', used in picture books, graphic novels, poetry and prose fiction. Furthermore, it suggests ways to encourage

anthropomorphism may alienate, degrade and other nonhuman species (Malamud, 2003, p 57). Such conflict is summed up by Samantha Hurn (2012), who claims, 'For some humans, animals can be physical manifestations of gods or ancestors. For others they are servants or slaves who can be put to work, or even tortured and killed to satisfy human wants and needs' (p 7).

As is the case with much children's fiction, contradictions and ambiguities abound, which is why engaging students in critical and creative thinking about the texts they read is so important. In the case of metaphorical animals, it is essential to consider the ways in which such narratives imprint valid or invalid messages about particular nonhuman species. For example, wolves are frequently vilified by writers of fiction, as is evident in fairytales such as 'Little Red Riding Hood', 'The Three Little Pigs' or 'The Wolf and the Seven Young Goats'.

In a scholarly article, 'The Big Bad Wolf: The Formation of a Stereotype' (2017), ecopsychologists Uta Maria Jürgens and Paul Hackett claim that 'in order to understand and mediate between people's views about wolves, it is not only wolf biology that must be understood but also how people subjectively perceive and understand wolves and their behavior' (p 35). They also focus on 'the implicit association of wolves with possessing the human characteristic of being evil' (p 34). Given that much of what children (and adults) know about animals comes from fictional sources, it is essential to understand what creators of narratives do with animals because, as Jürgens and Hackett argue, 'human beliefs and sentiments may impact on human-wildlife relations more generally' (p 34).

Some postmodern author/illustrators present 'the wolf' in a different light. In 'The True Story of The Three Little Pigs' (2004) by Jon Scieszka, the so called 'big bad wolf' is given a voice and allowed to tell his version of the story, which persuasively undermines the evidence presented by the pigs. Another delightful book, in this vein, is 'The Wolf

in Underpants' (2019) by Wilfrid Lupano, Mayana Itoiz and Paul Cauuet. This colourful picture book/graphic narrative takes place in an ambiguous forest, in which all the animals are terrified of an unknown howling wolf who lives nearby. For the animals of the forest, their community industry, commerce, education, and lifestyle are all based on their fear of the wolf. One day when the wolf actually comes strolling through their forest, the animals react in terror. However, their terror turns to dismay as they begin to question what they see. How can anyone feel seriously threatened by a cheerful wolf in red and white striped underpants? Different wolf tales indicate how stereotypes are created, and also how such clichéd notions can be instilled or undermined through fictional narrative.

'Migrants' - Who are these characters, where are they going, and why?

A thought-provoking recent publication featuring animals is 'Migrants' (2020) by Issa Watanabe. This compelling wordless picture book follows the distressing journey of a band of multispecies animals as they migrate from a dark leafless environment to an unknown future. It is an eye-catching visual narrative that permits multiple interpretations and is appropriate for a wide age range.

Created by a Peruvian author/illustrator and encompassing important issues such as environment, migration and refugees, the book is highly emotive, and the shared silent trauma of the migrating travellers is palpable.



'The Wolf in Underpants' by Wilfrid Lupano, Mayana Itoiz and Paul Cauuet (2019, Walker Books Australia) and 'Migrants' by Issa Watanabe (2020, Gecko Press)

This text is particularly worthwhile for a study on animal characters because it is so ambiguous. The equivocal approach to this visual tale offers a wide spectrum of opportunity for interpretation and response. It could be perceived as a cross section of the world's animals in the guise of humans (anthropomorphic), presenting the plight of animals being driven from their natural habitats in search of a healthier, more productive environment. This perspective raises many concerns linked to industrialisation, pollution, globalisation, climate change and ecology. From a different standpoint, the characters may be seen as humans depicted as animals (zoomorphic), thereby raising issues relating to political conflicts, human dispossession, migration and refugees. Either of these perspectives is likely to evoke different thoughts, personal connections, questions and interpretations for students, making 'Migrants' a compelling and inspiring text for activities that involve critical and creative thinking.

Ideas for teaching and learning

The following activities relating to 'Migrants' have relevance for students in Stages 3, 4 or 5. They embrace general capabilities from the Australian Curriculum, such as literacy (visual knowledge), critical and creative thinking (inquiring), and intercultural understanding (interacting and empathising with others), and they address the listed outcomes.

First reading

Following a first reading of 'Migrants', students should be encouraged to make notes individually and record the feelings this wordless text arouses. They may also briefly explain what they think the narrative is about. These individual responses can then be shared in a class discussion and/or kept for reviewing after a closer study of the text.

Closer analysis

Prior to a second reading, it is suggested that students examine the physical layout of this picture book. Noting, for instance, that the cover, end papers, and the pages of the narrative are all illustrated as double page spreads, thus providing a large horizontal orientation for all of the images. Students may be able to offer reasons as to why this type of layout has been used and what it conveys to a reader.

NSW English K-10 Syllabus

Stage 3

- A student thinks imaginatively, creatively, interpretively and critically about information and ideas and identifies connections between texts when responding to and composing texts (EN3-7C).

Stage 4

- A student thinks imaginatively, creatively, interpretively and critically about information, ideas and arguments to respond to and compose texts (EN4-5C).

Stage 5

- A student thinks imaginatively, creatively, interpretively and critically about information and increasingly complex ideas and arguments to respond to and compose texts in a range of contexts (EN5-5C).

Australian Curriculum: English

Year 5

- Use metalanguage to describe the effects of ideas, text structures and language features on particular audiences (ACELT1795)
- Recognise that ideas in literary texts can be conveyed from different viewpoints, which can lead to different kinds of interpretations and responses (ACELT1610)
- Create literary texts using realistic and fantasy settings and characters that draw on the worlds represented in texts students have experienced (ACELT1612)

Year 6

- Create literary texts that adapt or combine aspects of texts students have experienced in innovative ways (ACELT1618)
- Analyse strategies authors use to influence readers (ACELY1801)
- Plan, draft and publish imaginative, informative and persuasive texts, choosing and experimenting with text structures, language features, images and digital resources appropriate to purpose and audience (ACELY1714)

Year 7

- Reflect on ideas and opinions about characters, settings and events in literary texts, identifying areas of agreement and difference with others and justifying a point of view (ACELT1620)
- Compare the ways that language and

- images are used to create character, and to influence emotions and opinions in different types of texts (ACELT1621)
- Experiment with text structures and language features and their effects in creating literary texts, for example, using rhythm, sound effects, monologue, layout, navigation and colour (ACELT1805)

Year 8

- Explore the ways that ideas and viewpoints in literary texts drawn from different historical, social and cultural contexts may reflect or challenge the values of individuals and groups (ACELT1626)
- Understand and explain how combinations of words and images in texts are used to represent particular groups in society, and how texts position readers in relation to those groups (ACELT1628)
- Identify and evaluate devices that create tone, for example humour, wordplay, innuendo and parody in poetry, humorous prose, drama or visual texts (ACELT1630)

Year 9

- Interpret and compare how representations of people and culture in literary texts are drawn from different historical, social and cultural contexts (ACELT1633)
- Present an argument about a literary text based on initial impressions and subsequent analysis of the whole text (ACELT1771)
- Create literary texts, including hybrid texts, that innovate on aspects of other texts, for example by using parody, allusion and appropriation (ACELT1773)

Year 10

- Reflect on, extend, endorse or refute others' interpretations of and responses to literature (ACELT1640)
- Analyse and explain how text structures, language features and visual features of texts and the context in which texts are experienced may influence audience response (ACELT1641)
- Evaluate the social, moral and ethical positions represented in texts (ACELT1812)
- Create literary texts with a sustained 'voice', selecting and adapting appropriate text structures, literary devices, language, auditory and visual structures and features for a specific purpose and intended audience (ACELT1815)

In addition, the pictures are unframed, allowing the images to 'bleed' off the page. This is another significant feature that is open for interrogation. Consider, what meaning is to be gained from unrestrained images?

Questions such as, **who** are these characters? **where** might they be going? and **why?** will undoubtedly elicit a range of responses. By asking students to pinpoint aspects in the visual narrative that engender their responses, teachers can lead students to focus on various techniques associated with visual literacy. This book offers a very open-ended inquiry and will lead to many different, and often sensitive, reflections.

Questions to elicit deep thinking

(Responses may be provided by individuals, pairs or small groups of students and can be communicated in written or oral form.)

- The only human like character in the story is a skeleton. What do you think this character represents? Why?
- The skeleton character is accompanied by a blue bird that looks like an ibis. Do some research to find out the symbolism of the ibis and also the possible symbolism of its blue colour.
- What do the characters' eyes tell a reader? Give specific examples from the text.
- Although the characters are all different species, there appears to be a strong bond or camaraderie amongst them. Give different examples from the story where we feel their unity and explain how the illustrator conveys this.
- Explain the illustrator's use of colour in conveying meaning in this story, giving different examples from the text.
- How much can we infer from the gestures and expressions of the characters? Give examples from the book.
- Is it possible to infer anything about the age, gender, ethnicity, or class of any of the characters? Why/why not? Support your suggestions with textual references.
- Do you think this narrative is predominantly anthropomorphic or zoomorphic? Why?
- How does either an anthropomorphic or zoomorphic perspective alter the meaning of the narrative?



Extract from 'Migrants' by Issa Watanabe (2020, Gecko Press)

Additional activities

- Research a recent incident of migration (either of people or animals) and present who, where and why information behind the migration of these people or animal species.
- Select one scene from the book and retell the story of this section in writing (as a short story, poem, news report, or another type of text).
- Select one character from the book and write her/his diary entries over three days of their journey.
- Work with a partner or in a small group to create the script for a radio interview between a program host and one or more of the animals about their journey. (This may be presented as a recorded program or a transcript.)

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and models are important in science as they help us to reason, make calculations and formulate hypotheses, which could be further tested through investigation. Mediating the activities of investigation and explanation, as shown in the centre of Figure 1, is the core activity of argumentation. Argumentation involves the critique and debate of data and hypotheses. It frequently occurs among scientists internally within a research laboratory as well as externally in peer reviews, conferences and journal correspondences. The argumentation process often leads to further investigations or changes in the proposed theories, until a consensus is reached within the scientific community.

Explanation and argument

In the science classroom, explanation and argument are terms that are frequently used among teachers and students. However, their precise meanings are seldom clarified which often leads to confusion. According to philosophers of science, a scientific explanation is an account of why or how a phenomenon occurs according to a coherent theory (Braaten and Windschitl, 2011). There are many canonical explanations that students learn in school science, such as 'why did the dinosaurs become extinct?' or 'how is a shadow formed?' One of the issues in science teaching is that students often reproduce or regurgitate a 'standard' explanation instead of constructing an explanation on their own with some guidance. In a previous research, I developed a pedagogical strategy called premise-

reasoning-outcome or PRO to support students in constructing scientific explanations (Tang, 2015). Premise is an accepted theory, model or fact that is used as the basis or 'first cause' of an explanation. Reasoning is the chain of events that follow logically from the premise, and outcome is the phenomenon to be explained.

By contrast, a scientific argument seeks to persuade others by justifying a claim in light of supporting or contradictory evidence. Unlike an explanation that seeks to account for something that has already happened or is not in dispute, an argument always has a degree of uncertainty over the claim to be argued, without which there would be no argument (Osborne and Petterson, 2011). According to the philosopher, Stephen Toulmin (1958), an argument minimally must consist of a claim (a tentative proposition), data or evidence to support the claim, and a warrant that connects the data to the claim. Because a claim is in dispute, argumentation is a process that involves dialogic exchange of arguments between two or more parties to defend or refute the claim (Cavagnetto, 2010). A good illustration to distinguish explanation and argumentation is the question of 'why did the dinosaurs become extinct?' The most common explanation given is based on the premise of an asteroid collision. This collision triggered a chain of casual events from the massive release of dust particles to the creation of an atmospheric cloud, which eventually led to the mass extinction of dinosaurs. Although this explanation is

logical, the premise of a large asteroid collision has not been universally accepted among geologists and paleontologists. As such, this premise is currently a claim that requires more empirical evidence in order to convince the scientific community to accept it. Some of the best evidence supporting the asteroid collision so far are the Chicxulub crater (near Mexico) and the high concentration of iridium (a rare element) at the Cretaceous-Paleogene rock boundary. However, there are other possible claims competing with the asteroid collision claim, notably volcanic eruption and climate change, which are themselves supported by some empirical evidence. Only when the scientific community has conclusive evidence and no longer disputes a claim, then that claim will be accepted as a scientific fact (Latour & Woolgar, 1979).

I like to show how a controversial topic, such as the flat/spherical Earth debate, can provide rich opportunities for children to learn about scientific explanation and argumentation. The same method used by the ancient Greeks over 2000 years ago to determine the radius of a spherical Earth can be replicated as a real-world investigation for science and mathematics students. Using synchronous or asynchronous video conferencing, two classrooms in separate cities of roughly the same longitude, for example Brisbane and Sydney, can collaboratively measure the length of a shadow from a metre stick and its angle of elevation at a common time. Using some geometric reasoning, students in Years 7 and 8

can derive for themselves the equation shown in Figure 2 and use it to calculate the radius of the Earth.

The direct surface distance between Brisbane and Sydney is a verifiable fact at around 725 km. The angle of elevation in Brisbane and Sydney on 1st June at 12 pm are 40° and 34° respectively. I obtain these angles from [SunCalc](#), which is a great resource for planning purpose. Students should however measure these angles to obtain the data empirically on any given day. From these data, the radius of the Earth is calculated to be 6923 km, which is within 90% accuracy. The experimental error is largely determined by the precision of the instruments used to measure angle and distance, at ± 1° and ± 0.1 cm respectively. If the measurements are taken on another day, the angles of elevation in both cities will change. However, their difference will always be 6°, thus making the radius of the Earth a constant (as it should be).

This investigative task should be used not only to calculate the radius of a spherical Earth, but also to convince students that the Earth cannot be flat. As an argumentation activity, there are two competing explanations based on a spherical Earth and flat Earth model. The flat Earth model can actually be used to explain why the length of shadows are different in Brisbane and Sydney. However, this explanation would require the Sun to be fairly near to Earth such that its light rays to Brisbane and Sydney are not parallel but will meet at a particular point (See Figure 3). Based on the empirical data of 40° and 34° angles of elevation

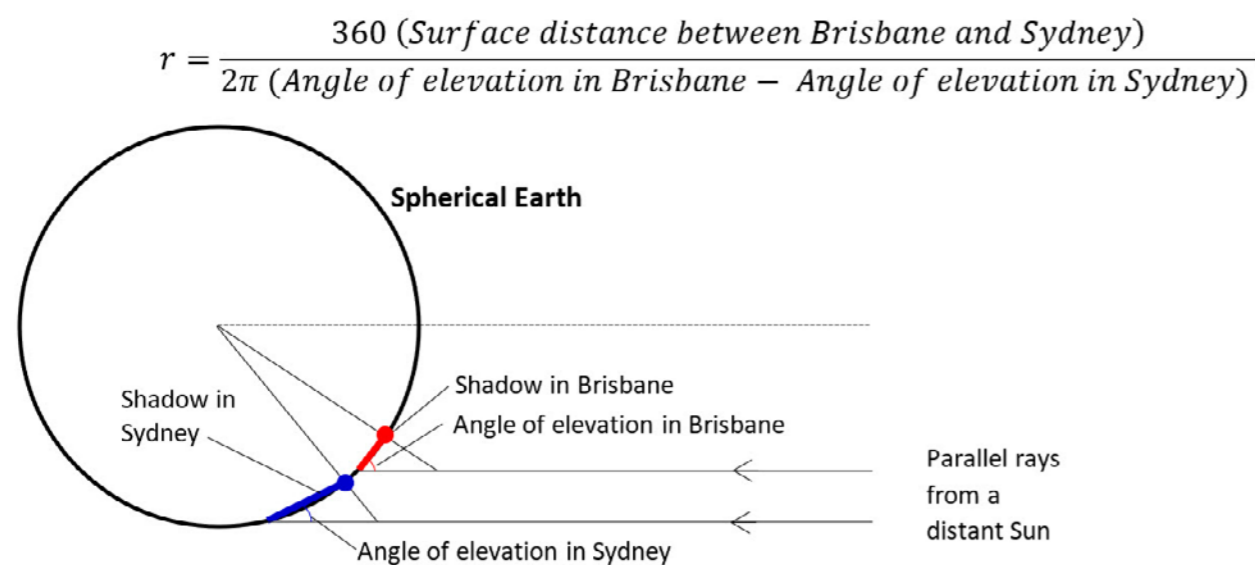


Figure 2. Explanation of shadow differences using a Spherical Earth model (not drawn to scale)

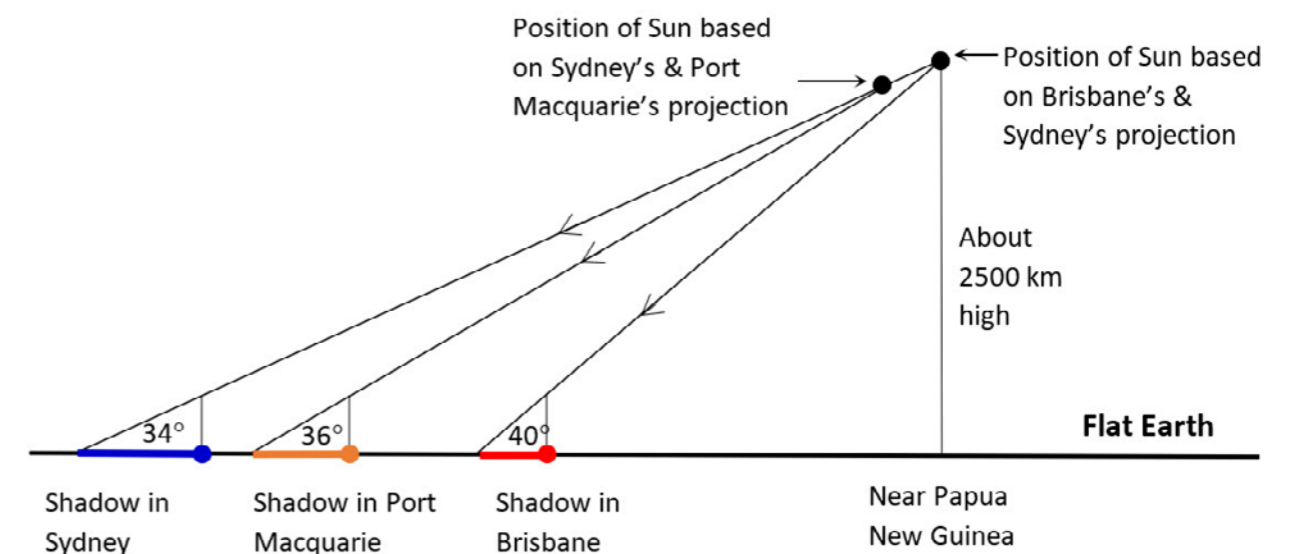


Figure 3. Explanation of shadow differences using a Flat Earth model (not drawn to scale)

in Brisbane and Sydney on 1st June at 12 pm, this would put the Sun at a vertical height of 2500 km and 2970 km North of Brisbane (somewhere off Papua New Guinea). Not only is this conclusion absurd, the flat Earth model also cannot accommodate a third data point. If another reading is obtained from say Port Macquarie, the lines projected from the angles of elevation in the three cities will never meet at a singular point, thus implying that the flat Earth model is untenable. Therefore, students can use these empirical data from the real world to construct explanations and engage in peer argumentation to support or refute various claims about the Earth's surface.

Syllabus links

This argumentation activity is suitable for secondary school students in a science, mathematics or integrated STEM classroom. It can also be attempted by primary school students, provided that someone does the mathematics for them. Students will learn disciplinary concepts and skills such as the solar system, light and shadow, measuring distance and angle, properties of circle and triangle, and trigonometry. But more importantly, they will also experience firsthand how scientific knowledge is constructed through the process of explanation and argumentation instead of just accepting it as an unchallenged fact from textbooks or the internet.

The increasing prominence of fake news, conspiracy theories and science denialism pose a significance threat to the functioning of a democracy. Science, as a human endeavour carried out for many centuries, has developed a unique way of knowing that counteracts the dangers of post-truthism through the scientific practices of empirical investigation, theory-driven explanation and evidence-based argumentation. As such, it is not only the knowledge of science that we need to pass on to the next generation, but also the rich cultural practices of science. This must be the vision of scientific literacy to ensure our future generation is able to use science to critically inform their personal decision-making, civic engagement and political discourse. As we witness the human cost due to numerous fake news reports during COVID-19, this vision of scientific literacy is not just a distant aspiration but is now an immediate priority that impacts our democracy.

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In her current role as a curriculum advisor at the NSW Department of Education, Lorri supports schools in curriculum implementation. Lorri's PhD research centres on 'Collaborative Teacher Professional Learning: Investigating Impact and Sustainability' (2015). Recent papers for teachers encompass publications and co-publications for English, including those focusing on the alphabetic principle, writing, spelling, collaborative teacher professional learning and teachers as researchers and practitioners. Lorri particularly enjoys collaborating with teachers on writing English units using the vehicle of quality texts.



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Cathy Sly is an independent researcher and writer. After teaching English in NSW Department of Education high schools for many years, she completed a PhD in Media, Communications and Creative Arts at Deakin University. Cathy has a keen interest in visual literacy and multimodal literature for readers of all ages. She has presented at academic conferences and contributed to scholarly publications both in Australia and overseas.



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Kok-Sing Tang is an Associate Professor at the School of Education and Discipline Lead of the STEM Education Research Group at Curtin University. He received a BA and MSc in Physics from the University of Cambridge and a MA and PhD in Education from the University of Michigan. His research examines the role of language, discourse, and representations in supporting scientific literacy. He is the author of the book 'Discourse Strategies for Science Teaching and Learning', published by Routledge.