Maura Sellars *Editor*

Numeracy in Authentic Contexts

Making Meaning Across the Curriculum

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About the Editor

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Part I
Introduction to Book: Understanding Numeracy

Traditionally, mathematics has frequently been observed as a ‘stand-alone’ subject, one that demands its own language, symbolic representation, structures and thinking. It has often been neglected and excluded from integrated units of work, blended learning and cross-curricular projects. This book seeks to present a different perspective on teaching and learning in mathematics, by investigating the potential of exploring mathematics knowledge, skills procedures and thinking when used as embedded numeracy in other disciplines. Whilst cultural and social differences have always existed in Australian schools, the responsibility of ensuring that every child is supported in reaching their full potential, the emphasis placed on improving students’ mathematical outcomes and the increasing diversity of the cohorts of students in regular classrooms, including students with special needs, students with no English skills, students with backgrounds that include refugee experiences and numerous other individual learning needs; todays, teachers are facing an increasingly complex and ethically demanding workplace. Consequently, it may be productive to develop a more holistic approach to teaching and learning some of the most important foundational skills, which, for the purposes of this text, are those that focus on mathematics and numeracy. It is proposed that investigating the embedded numeracy in other discipline areas and making explicit, appropriate links with teaching and mathematics could not only serve to address the presumed isolation of mathematics as a discipline area, but also invest students with a real opportunities to identify mathematics in action in their own lives, to construct meaning in the contexts of their own use of mathematics as numeracy competencies and, as a result, improve their learning outcomes in mathematics, despite diversity and difference.

This book has been developed to support and encourage the teaching of mathematics for teachers in Australian schools whose professional interactions focus on the teaching and learning relationships and achievements of students aged 5–13 years. Many of these teachers are not specialist teachers of mathematics but teach a wide range of subjects. It is in this context that strategies and suggestions for identifying the numeracy embedded across the curriculum are made available to teachers in primary schools, middle schools, central schools and schools which enrol students from their first to their year of formal schooling. However, there are a number of suggestions also for teachers who are discipline orientated or who seek to support older students who struggle to improve their mathematical learning outcomes. Part I of this work comprises a rationale for the work presented in Part II. It presents a rich and thorough picture of the importance of numeracy in twenty-first-century education, an argument for teaching numeracy and mathematics in a holistic and meaningful manner and an emphasis on the understanding of the overall importance of context and clientele, irrespective of degrees of diversity and difference.

The theoretical underpinnings found in Part I of the work seek to both inform teachers and to promote reflection on the importance of numeracy competencies and how best this may be facilitated in their own context and with their own students. The discussions around the professional and ethical debates that are associated with ethnomathematics and its inclusion in schools, the role of mathematics and numeracy in supporting greater social justice or perpetuating discrimination and exclusion, the relationships between literacy and numeracy competencies and the exploration of appropriate pedagogical strategies contribute to promoting a deeper understanding of the critical role numeracy that plays in the everyday lives of students and their school communities, and the wider society in which they live.

These discussions also serve to highlight the potential of mathematical learning to contribute effectively to success across the other discipline areas that are the fabric of school curriculum for young students. A focus on the brain and workings not only presents the most current understandings of potential of the brain and the ways in which tasks can be developed to support students' efforts to become increasing analytical, creative problem-solvers, but indicates how a more holistic approach to developing numeracy capacities and mathematical knowledge can be established when planning for 'teaching with the brain in mind' is explored through the multiple pathways explored in Part II of this work. Engaging with the pedagogies of other discipline areas, whilst not traditional mathematics pedagogies, presents a unique opportunity for teachers to identify the mathematics embedded as numeracy components across the curriculum in diverse areas of learning and to link these with more formal learning in mathematics.

The process of making explicit links with the numeracy competencies embedded in other discipline areas is not only a sound pedagogical practice as it places the learning within the students' experience but also an opportunity for teachers to develop a holistic and inclusive approach to teaching and learning in mathematics. It is of no real consequence whether students learn the skills and knowledge that comprise mathematical learning and working in the context of completing tasks in other learning areas or in the mathematics classroom; whether, for example, they understand and effectively use repeating and growing patterns because they like dancing or music. What is important is that students have opportunities to develop these capabilities and then to reflect, communicate, explain and justify their learning effectively and appropriately in mathematical language and symbolic representation. Much of what students discuss in other areas of learning as numeracy components can be linked with their outside school activities, their numeracy as social practice and their own construction of knowledge. This may also enrich their potential to engage positively and successfully with the ways in which mathematical tasks are presented.

Part I also includes a discussion of Indigenous students as mathematicians and provides a compelling example of how mathematics is socially determined and used as social practice. This discussion illustrates a worldview in mathematics that is very different from that which is promoted and compulsory in Australian schools and presents many opportunities for teachers to reflect on the importance of context, the validity of pedagogies and the degree of acceptance that is afforded to different ways of doing and knowing in Australian classrooms. Also included is an informative chapter on the complexities of mathematics learning for students with language backgrounds other than English. This chapter not only stresses aspects of mathematical language which may be problematic but also indicates grammatical and syntactical features which may need to be investigated and explained to non-native English speakers which are commonly and intuitively interpreted by students for whom English is their first language. A substantial number of common misconceptions in, for example, mathematical description and other mathematical explanations are identified and strategies suggested to support learners acquire the language proficiencies which can support mathematical understanding and thinking.

The development of sample lessons and ideas for extending both discipline knowledge and associated competencies are presented in Part II with an introduction that indicates how these lessons may become an integral, related part of holistic approach to improved mathematical expertise in the initial years of schooling.

Mathematics and Numeracy in a Global Society

Maura Sellars

Introduction

Numeracy is a contentious issue. There are multiple definitions; series of explanations that describe the relationship numeracy enjoys with mathematics; and even perspectives that interpret numeracy and mathematics as identical sets of skills, concepts and strategies (for example see Sullivan, 2011). Identified with literacy as one of the 'terrible twins' that underpin all educational endeavours, numeracy remains a rather confused and confusing concept for many teachers who are responsible for teaching mathematics skills, concepts and knowledge, and for supporting students' attempts to translate these into numeracy capabilities. It is difficult to determine exactly how this current situation has evolved; what is certain, however, is that overall, teaching and learning in numeracy in Australian schools. Historically speaking, it has not attracted the same degree of financial, social or academic attention as literacy, despite the two being tagged together in a number of government initiatives (Australian Government, 2011, 2013). This may be because literacy is perceived to be the single most important life skill for students and so matters more to parents and teachers. It may be because being innumerate is not thought to attract the same social stigma as being illiterate (Gregorian, Griffiths, & Cahill, 2008) or it may be simply that the relationships created by mathematics and numeracy are not always clearly delineated (Sullivan, 2011).

Irrespective of these considerations, it is proposed that numeracy is a worthy 'twin' to literacy, that it is equally important, and that it is increasingly necessary for students to be numerate in order to make meaning of their worlds and to become active, engaged and informed global citizens (Parsons & Bynners, undated). For the purposes of this writing, mathematics are the skills, strategies, concepts and cognitive capacities that are associated with more formal, content-knowledge

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development, while numeracy is conceived as the mathematical knowledge with bearing on other areas of learning, in all aspects of everyday life and in making meaning from personal experiences. Like two sides of a coin, they are indispensable one to the other. However integrated they are, though, they still look different and require different interpretations.

Numeracy

The simplest and most useful definition of numeracy for this text comes from Macmillan (2009 p. 1). She states, 'Numeracy is a social and cultural perspective for discovering and thinking about mathematical knowledge and applying it to fulfil the purposes of our everyday lives' (p. 1). Because it is part of everyday life, the application of mathematics to personal contexts and situations may not be explicitly conscious. There is a degree of automation about many daily interactions and personal actions, such as shopping, catching buses and trains, spending specified durations of time for lunch, etc. These become habitual, and, whilst they are the practical components of mathematics activities undertaken in everyday life, possessing skills at this level is not always sufficient to be identified as an individual who is authentically numerate in the twenty-first century. Currently, in order to be considered numerate, individuals need to have the capacity to make sense of mathematical concepts as they are applied to their personal contexts and needs in a wider sense, as global, national and local citizens.

What Does the Literature Say About Numeracy and Globalisation?

Globalisation itself is considered by some as the 'Americanisation' (Gidley, 1998) of the rest of the world, despite the fact that globalisation is orchestrated by international or non-national entities similar to those who have highjacked education in general to serve the economy.

Ethnomathematics

The advent and continued rise of technology has brought the rest of the world into Australian homes, classrooms and workplaces at an ever-increasing rate. It has broken down the historical barriers of time and place in terms of accessing, storing and retrieving information about local, national and international contexts. In turn, as recipients of this wealth of information, Australians, most especially young people, are now able to understand themselves not only in terms of national identity, but also as part of a much more complex social structure: the world community. This membership of the world-wide community is commonly known as 'global citizenship', and it brings with it a complicated array of personal, political, social, cultural, ethical and financial dilemmas and responsibilities. Falk (in Atweh & Clarkson, 2010) describes two types of globalisation. One is globalisation from 'above' which is the spreading of consumerism and the involvement of huge transnational conglomerates which dictate business and political life. The other is defined as globalisation from 'below', and this is reflected in the transnational common concerns for human rights, the environment and end of poverty, oppression and the forces of collective violence such as war.

Whilst globalisation itself is perceived in terms of various definitions, it is generally agreed to be the result of redefining, crossing and mobilising physical borders, which has made the world 'smaller' by increasing the consciousness of diverse populations to cultural, social and political challenges world wide and by delivering many of these challenges into hitherto relatively homogeneous or stable communities. The term globalisation is often used simultaneously with internationalism; however, this does not necessarily mean that they are synonymous terms. Atweh and Clarkson (2010) argue that they are undoubtedly related in that intense internationalisation may easily lead to globalisation, but they caution that while this may be happen in the larger picture, the issues that are at the centre of globalisation need to be considered in terms of local impact and context. It appears that context, always acknowledged as a factor in teaching and learning, is becoming increasingly important as globalisation demands that the increasingly diverse learners in classrooms are given access to learning in ways that allow full participation (Ingram, Seashore, & Schroeder, 2004). This has considerable implications for teaching and learning in mathematics (Atweh & Clarkson, 2010), as economic and political environments have considerable impact on pedagogy (Porter, in Thomas, 2010). This can be observed in the narrow focus of the current Australian mathematics curriculum and accompanying pedagogies, which heavily stress learning that supports the current climate of economic rationalism, to the detriment of individual learner difference and cooperative and collaborative pedagogical strategies.

Mathematics is considered by some to be superior to other forms of knowledge in modern society (Stillman & Balatti, 2010: 313). This claim may reflect the argument that mathematics education and democracy are closely connected (Skovsmose & Valero, 2010). It certainly reflects the importance of mathematical thinking, literacy and criticality in the contexts of national, non-national and global outcomes and economic needs in relation to technological and scientific advances. It also highlights the importance of numeracy in the context of personal mathematical fluency to better understand the role of mathematics in the rapidly evolving nature of society and culture. In acknowledging the political dimensions of mathematics teaching and learning, Skovsmose and Valero (2010) present the three theses or perspectives on this link between mathematics and democracy. The first is its intrinsic significance to participation in civic and political life. Mathematics learning enables the development of logical, well-reasoned debate, and empowers individuals to participate fully in democratic discourse and processes.

Second, the perspective that places mathematics on the other side of the argument is that it is used in education to actually disadvantage students, in that teaching and learning in mathematics plays a significant role in excluding and segregating students who find mathematics difficult to understand. Consequently, individuals who are able to achieve high levels of mathematical thinking are valued in society, and they become the decision makers that accumulate significant economic, social and cultural capital (Bordieu, 2011; Bordieu & Passeron, 1990), which contributes to the role played by education in social reproduction and separating those who are able to make decisions about life's opportunities and those who are not. Indeed, historical episodes of exclusion, apartheid and marginalisation indicate that by preventing specific groups of individuals from engaging with mathematical teaching and learning, political regimes have prevented those groups from engaging in political and civic life in a democratic manner (Skovsmose & Valero, 2010).

The third perspective that links mathematics and democracy is that of critical relationship. This perspective dismisses the two other perspectives as absolutist, claiming instead that mathematical teaching and learning can be both the thesis of resonance and the thesis of dissonance. While highlighting the fact that the historical tendency to treat mathematics as a discipline area that remains untouched by subjectivity and social and cultural implications maintains the political agendas, beliefs, values and interests of those who perpetuate this viewpoint, Skovsmose and Valero (2010) emphasise the constantly evolving social nature and functions of mathematics in the increasingly complex circumstances that characterise modern societies. This environment means that mathematics are constantly changing, that the pedagogies associated with the teaching and learning of mathematics need constant revision, and that the social and cultural contexts of the students who are learning mathematics need to be taken into consideration.

If the purpose of mathematics education is to facilitate numerate, interactive citizenship and not just to create pure mathematicians, then all students need to able to make authentic links to the mathematics they learn in school and to the mathematical experiences they come into contact with in their own lives. What also needs to be considered is that mathematical experiences are found within other subject areas of the school curriculum (Skovsmose & Valero, 2010). The learning in any disciplinary area interacts with the leaning in another, either in a positive, supportive manner, or as a counteractive or counterproductive influence. The interpolation of all these contexts of mathematics learning is of critical importance for democratic, global, informed citizenship.

> Therefore, mathemacy should be a prioritized competence, allowing people to engage with mathematical questions and, simultaneously, with a critique towards the impact of mathematics in society. The association of mathematical education and critical citizenship should be both a theoretical and developmental issue to keep in focus (Skovsmose & Valero, 2010: 40).

However, the globalisation of society has resulted in considerable degree of diversity in classroom populations.

This, in turn, has presented challenges in the teaching and learning of the critical mathematics perspective that is required for socially responsible participation in society. A considerable debate around the topic of ethnomathematics remains unresolved, with various contributors to the discussion reflecting their own theoretical perspectives and social contexts (for example see Graham, 1988; Pinxten & François, 2011). A critique of D'Ambrosio (1985, 2001), who regards formal mathematics as part of the power play of aggression, can be found, along with a critical evaluation of the arguments regarding the integration of mathematics as cultural practice (ethnomathematics), and mathematics that are part of the institutionalised curriculum in schools, can be found, for example, in Rowlands and Carson (2002) and an earlier discussion of different, culturally based mathematical notions in Bishop (1988). Other scholars (for Example, Barton, 1996; Boaler, 1993; Robyn Zevenbergen, 2004) have noted the richness of ethnomathematics and it potential to enable students to make meaning of their mathematics learning. The study of multiple mathematical models, would, necessitate that teachers develop new pedagogies that reflect cultural understanding, inclusion and respect for the practical needs and experiences that students bring to their classrooms. The student–teacher interactions, the sensitive selection of resources and materials and the successful learning of all students do need to become priorities in every classroom, in order to ensure that all young Australians are equipped with the mathematical skills necessary to take their place in the increasingly technological, multicultural environment of Australian society (Ministerial Council on Education, 2008).

The issues and responsibilities that today's students will face as global citizens will necessitate that they each develop mathematical skills and competencies that were hitherto not necessary for all members of society. Amongst these are capacities for critical thinking and analytical reasoning (Sparks, 2012). These cognitive capacities are not only vital for understanding numeracy, but are regarded as imperative for academic success and active citizenship in general (Afamasaga-Fuata'i, 2008; Ahana, 2014; Cottrell, 2003; Halpern, 1999; Lipman, 1987; Paul, 2005; Watson, 2008a, b). One example of how these critical thinking skills and capacities for analytical reasoning, which are heavily dependent on the logic and reasoning developing the study of mathematics, comes from Andreotti (2006). In her discussion of those societies who are globalised and those who do the globalising, Andreotti argues that critical global citizenship requires not empathy for others, but justice. In order to achieve this, individuals need to have the capacities to understand information that is increasingly presented in statistical and data based formats. They are required to have the competencies to evaluate what information is provided and what is excluded. They must know what figures and data reveal about underlying prejudices and bias, and ways in which information is managed in order to serve the purposes of the stakeholders. Individuals ought to be able to detect the means by which they are being subtly predisposed to make specific decisions and judgments.

Another example provides an insight into the ways in which school students not only are able to perceive themselves as global citizens, but also have opportunities to use their numeracy competencies to perform problem-solving activities as citizens in another society. Simmt (undated), created a fictitious society to which all her year five students belonged. The students were able to identify, strategize solutions and solve lifelike problems during citizenship lessons by using their numeracy competencies. At all levels of society, individuals will, in the future, need what is essential for competent citizenship in any context: That is, numeracy skills that have the capacity to inform their everyday practice, to detect the significance of seemingly ordinary things and to determine the hidden cultural significance of events and changes to dominant social practice.

What does this mean for you as a teacher of numeracy?

- Society is changing at an unprecedented rate, and for students to gain the skills to make meaning of their personal worlds and to become responsible, ethical members of local and global societies, they must have sophisticated capacities in mathematics and numeracy.
- Decisions made as global citizens need to reflect ethical personal values and belief systems. These can only be made in response to what is critically understood and evaluated as personally valuable and important.
- Responses to personal contexts and relationships require individuals to have the competencies to develop personal meaning and to understand their increasingly complex worlds in the contexts of both local and international citizenship.
- Critical mathematics, and its application in everyday life as numeracy competency, needs to become a priority in the teaching and learning of mathematics skills, strategies, and concepts.
- *For example: The Year Three Health lesson about healthy choices is a good beginning to the sorts of skills students will need as active citizens. It focusses on getting students thinking about their own choices in the context of a party which may have foods that were once an annual treat but which are now taken for granted, not so healthy choices. In this lesson the students may question traditional party food and substitute other foods which are better for their health.*

Numeracy as Social Practice

The ethnographic or cultural use of mathematical knowledge, skills and understanding, for specific, personal purposes in everyday interactions, is well documented (Baker, Street, & Tomlin, 2003; Kleemans, Peeters, Segers, & Verhoeven, 2012; LeFevre et al., 2009; Saxe, 1988; Street, Rogers, & Baker, 2006). Using the insights into the multiple ways in which literacy is used in different cultural contexts, Street (2003) determined that teaching literacy in a manner which reflected only the dominant western culture, and which focussed on literacy as a culturally and socially neutral technical skill, was not only of limited benefit to many of the participants, it also did not automatically have an impact on other aspects of development such as social and cognitive practices (Street, 2003: 77). Identifying this model of teaching literacy as the 'autonomous' perspective, Street then developed a more culturally sensitive model of literacy which posited that literacy is always 'embedded in socially constructed epistemological principles' (Street, 2003: 77). This perspective was identified as the 'ideological model' of literacy. In different cultural and social settings, individual understandings of the nature of numeracy also vary in response to the purposes for and contexts in which they are implemented. Baker, Street and Tomlin (Baker et al.) investigated the strategies of a number of students in three different schools in order to establish the degree to which the social and cultural backgrounds of the students impacted their numeracy strategies. They concluded that these factors were of significant importance in the conceptual and strategies students used.

Social and cultural contexts have only been recognised as an area of importance for teachers of mathematics since the 1980s (Thomas, 2010), although there is no real recognition that there are other systems and practices around mathematics and numeracy that do not synchronise readily with the Western, scientific processes that decontextualized and depersonalise, and which are the basis of Australian curriculum and operations. Learning contexts are continuing to emerge as a fundamental focus for educationalists, as research into different ways of knowing and learning illustrates the critical nature of these diverse backgrounds with regards to student participation and engagement in the regular educational process (Burgoyne & Hall, 2007; Cassidy & Gow, 2005; Harris, 2013; Keddie, 2012; Matthews, 2008; Taylor & Sidhu, 2012; Wilkinson & Langat, 2012). This, in turn, has several implications for teaching and learning in numeracy, as many attempts by educationalists to improve the students' results had previously focussed on considerations such as the teacher expertise, pedagogies and school and educational structures. The impact of cultural differences in numeracy thinking and social conditions such as homeless and poverty had not routinely been considered in these attempts. Using the terminology developed by Street, but replacing literacy with numeracy, numeracy events can be observed as specific occasions in particular contexts which are experienced by students, and which are solved in socially and personally meaningful ways that reflect both the individual's social and cultural interpretation of the event and the ways in which they have derived meaning from it. Similarly, numeracy practice can be interpreted as the broader cultural and social way of doing mathematics and numeracy.

In an effort to develop suitable pedagogical strategies for the successful interaction of ethnomathematics and institutional mathematics, Street, Rogers and Baker (Baker et al.) investigated the mathematical practices of those engaged with this work. In one example, Street, Rogers and Baker (Baker et al.) found that ethnographic strategies helped teachers of women in rural India to support learning in numeracy. In the process of observing current practices and examining the participants' strategies for counting and measuring and other numeracy skills, the teachers were able to develop suitable pedagogies based on the participants' epistemological knowledge. They indicated that:

> Developing such an approach involves helping the participants - in this case adult education trainers — to identify local cultural meanings in context, reflect upon their own assumptions and values, and then design curriculum and pedagogy that will build on such local knowledge. (Street et al., 2006: 33)

In this way, teachers and the women were able to share the common meanings that were used in this social context and use them to support further learning. Many of the pedagogies that are commonly implemented or recommended in programmes designed to support increased competencies in numeracy have the potential to reflect one type of cultural and social understanding of numeracy, whilst neglecting many others, unless teachers are able to design pedagogies that reflect the social and cultural knowledge that students bring to their classrooms. Developing a pedagogy that facilitates shared mathematical meanings is critical to meeting the mathematical and numeracy needs of diverse students. Without this, many students will not develop sufficiently robust skills to accommodate further learning and will be disadvantaged in the wider social and civic environments.

One perspective that clearly illustrates the means by which individuals are advantaged or marginalised in schools, and by which the social stratification is replicated by mainstream education, is found in the work of (Bourdieu, 1986, 1990; Bourdieu, Passeron, & Saint Martin, 1994). The framework developed by Bourdieu is frequently used by researchers and others to determine the degree of access specific groups of students in schools have to the teaching and learning interactions in classrooms. Bourdieu theorised that there are four different types of capital that impact the relationship between social class and education, and subsequently on social class and career opportunities. Economic capital is exactly what its name suggests. This form of capital is about money, possessions, property and other monetary advantages. It is obvious that money can play a part in educational opportunity and success. The other types of capital are not directly related to monetary wealth; however, Bourdieu posits that they also have a direct impact on educational opportunity and success. Cultural capital is about the attitudes, social habits, perceptions, language usage and even personal presentation that indicate the social class of students' backgrounds. He terms this *habitus.* In society generally, both individuals and institutions such as schools learn to read these clues and are able to readily discern the social class to which individuals belong. Bourdieu identifies three types of cultural capital: embodied cultural capital, including linguistic capital; objectified cultural capital and institutionalised cultural capital.

Embodied cultural capital is not confined to the ways in which individuals present themselves physically; it also refers to the types of customary practices and leisure time activities in which individual of specific social classes typically engage. A significant part of embodied cultural capital is linguistic capital, which is not only represented in vocabulary use, but also in patterns of communication, inferred and interpretative meaning and degree of linguistic sophistication. Much of his thinking about linguistic capital is supported by Bernstein's (1990) work on linguistic codes. Bernstein argued that students from working class backgrounds do not always include complete information in their communications; instead they rely heavily on some taken-for-granted, shared understandings and meanings. Bernstein indicated this type of communication was a restricted code. In comparison, students from middle-class backgrounds have the capacity to use elaborated codes, where they provided all the necessary information in their communications. It is reasonable to state that the most effective manner in which to communicate in school settings is to use elaborated codes. By default, therefore, restricted codes have the potential to disadvantage students at school.

Objectified cultural capital refers to the physical things that give people status. In school settings, this may mean the latest technological tools, sports equipment and so forth. In the wider community, it may refer to cars, jewellery and other items of value which can easily be exchanged for economic capital. Institutionalised capital is about the connections that individuals have to institutions. One example would be the school that an individual attended or the particular university from which they obtained a degree. This cultural capital is also readily exchanged for economic capital in the terms of job or career opportunities. Social capital is the connections that people have to others. A wide network of influential people, who have themselves considerable economic and cultural capital, gives the individual social power and can provide needed opportunities that cannot be accessed by those without these connections or memberships to exclusive groups or clubs. Symbolic capital is about prestige within groups.

In a year-long study of two primary classroom mathematics interactions, (Zevenbergen, 2010) found that students who came to school with the appropriate linguistic 'habitus' (Bourdieu, 1986, 1990) were able to talk and generally interact in ways that were understood and that were congruent with the ways in which teachers in classrooms interacted verbally with the students. Conversely, students who did not have the linguistic habitus of school interactions were marginalised by the classroom pedagogical practices. It was found that the triadic dialogue that was commonly used in both classrooms was engaged with readily by the middle-class students, as they appeared to comply with, and participate in, this for of dialogue. Triadic dialogue is described by Lemke:

> Triadic dialogue is an activity structure whose greatest virtue is that it gives the teachers almost total control of the classroom dialogue and social interaction. It leads to brief answers from students and a lack of student initiative in using scientific language. It is a form that is overused in most classrooms because of a mistaken belief that it encourages maximum student participation. The level of participation it achieves is illusionary, high in quantity, low in quality. (Lemke in R. Zevenbergen, 2010: 206).

The working class students, however, had difficulty, resisted engaging or did not appear to understand the structure and meaning of the triadic dialogue. As this dialogue was used extensively in the introductory part of the mathematics lessons, both to allow the lesson to progress smoothly and to introduce more mathematical content, the working class students were effectively excluded in some degree from the mathematical content and from the opportunity to mentally prepare for the activities which were to follow. These students were all aged 10 to 11 years and in the second to last year of primary schooling, and so this situation also had another impact. As this dialogue is extensively used by secondary teachers, the working class students were further marginalised by the lack of preparedness they would have for learning mathematics in secondary contexts. In this pedagogical dialogue, students from particular cultural and social background are advantaged, to the detriment of the learning of those from other social and cultural backgrounds. In this way, certain common pedagogical strategies fail to prepare many students to play their part in civic life in this technologically advanced society.

It is foreseeable that the changes in cultural and social practices that are resulting as technology advances and reaches every household and public space will present problems for citizens who are not authentically numerate. This is because the social and cultural changes are rapid and complex. Individuals who do not understand the foundational principles of mathematics will not be able to adapt and change their numeracy practices as effectively or as efficiently as those who do. The defining characteristics of numeracy that may need to be adapted, revised or renewed to be effective in a changing social context may be described as follows:

- It is a personal, social and cultural activity; and as such is unique to the user.
- Practices may differ from individual to individual depending on need. For example the numeracy needs of a truck driver would be substantially different from the numeracy needs of a teacher. These vocational numeracy competencies may also differ from the everyday numeracy needs of living in society in general. It is accepted that all teachers are teachers of numeracy and literacy (Australian Association of Mathematics Teachers, 1997).
- It requires an understanding of the concepts, strategies and knowledge of mathematics.
- It can be developed in tandem with formal learning in mathematics and in informal contexts of everyday interactions.
- What it is to be numerate is, as always, a constantly evolving capacity. It is not a static competency for all contexts and all times, although individuals who have robust knowledge in numeracy are more likely to respond more easily to the changing demands of personal, social and cultural numeracy skills than those who do not.

What does this mean for you as a teacher of numeracy?

- Teachers need to know about the backgrounds and culture (Aunio, Aubrey, Godfrey, Pan, & Liu, 2008) of their students because community knowledge and home language mediate the use of mathematics as numeracy practice, especially in the context of social justice numeracy (Diez-Palomar, 2006; LeFevre et al., 2009; Spielman, 2009).

- Students do not automatically learn numeracy skills in mathematics times in classrooms; they need to have multiple opportunities to develop competencies in numeracy by solving real problems.
- Informal school contexts such as playing games on the playground and shopping at the canteen are all sound opportunities for students to develop their numeracy competencies.
- Other, more formal contexts include engagement with other areas of learning. These all provide opportunities for the development of numeracy skills.
- Individual strategies and actions are always acceptable in numeracy practices as students interpret the contexts and construct the accompanying numeracy actions that are necessary to make personal meaning. There is no one correct way.
- Numeracy practices can be explained, shared, justified and enhanced by engagement in discussions that are logically constructed.
- Some traditional pedagogies such as triadic dialogue do not encourage quality participation in ways that are equitable and inclusive of all students.
- *For example, the Year Five/Six lesson in Visual Arts which examines Frank Stella's work 'Untitled' give students multiple opportunities to interpret and describe the work in any mathematical terms that they can use appropriately and to explain their interpretation in ways in which the can 'show what they know' as individuals.*

Anticipating Change and the Role of Numeracy

As a reaction to the changing nature of society in America of the 1970s, Steen (1987, 1990, 1997, 2001a, 2001b), foresaw the impact of an increasingly technological, global society. He proposed that numeracy was the 'new' literacy that needed for Americans to survive and make decisions in a society where information was becoming increasingly available, larger in volume and more quantitative in nature. He argued that only one in ten adult Americans had the numeracy skills to solve problems of two or more steps, understand the economic implications of a standard tax rate or explain the complications involved in the research to find a cure for AIDS. He also notes that numeracy means different things to different people, that it has many different functions, that it is linked inextricably with literacy and that it both 'shapes and is shaped by society' (Steen, 1997: 2). What is most interesting, however, is that while Steen argues that numeracy, quantitative literacy or mathematics—whichever term individuals use for these capacities—is a fundamental artefact of any society, he also posits that, towards the end of the twentieth century in America, such little progress was made in the teaching and learning of numeracy simply because, apart from the basics, there were no consensual goals relating to the numeracy needs of the future or the directions in which they needed to be developed. To some degree, that situation no longer exists in Australian schools.

Australian curriculum documents are prefaced with rationales that include notions relating to teaching for the skills that students will need to live as active, productive citizens in the future. While the impact of these documents on schools, classrooms and on the capacities of students themselves remains to be seen, the documents relating to the nature of numeracy itself (ACARA, undated-b), its purpose in terms of the Goals of Education for Young Australians (Ministerial Council on Education, 2008) and a developmental sequence of mathematical concepts, knowledge and strategies (ACARA, undated-a) have, at the very least, provided some common national goals and understandings for Australian educators. However, in order to fully support educational endeavours across the diversity of Australian social and cultural contexts, a paradigm that includes these notions of numeracy as personal and social practice, numeracy as complex critical thinking in local and global environments and numeracy as opposed to, yet part of, mathematical learning, needs to be explored.

What does this mean for you as a teacher of numeracy?

- Numeracy skills exist in every cultural and social context as an integral part of its fabric.
- Numeracy, like literacy, is fundamental to students' capacities to make meaning of their world.
- The increasing representation of information as quantitative in nature means that students need to have the competencies to verify, analyse and evaluate the information that they are learning about in a variety of contexts.
- Social practice indicates that numeracy is a very personal capacity and reflects the needs of the user.
- Numeracy will have different meanings for different students, depending on their numeracy experiences at school, at home and in other contexts in which they interact.
- Social and cultural factors both influence and are influenced by understandings of numeracy, so students from diverse cultural and social backgrounds will have various ways of using their numeracy strategies and explaining their thinking about numeracy concepts.
- The technological society that is part of many Australians' lives has changed the nature and complexity of the numeracy skills that are needed to participate in this society.
- This diversity needs to be accepted and accommodated in teaching and learning contexts.

- It may be difficult for teachers who have very different backgrounds to those of their students to support the development of students' numeracy competencies in ways that are meaningful to the students—it will require some thoughtful reflection.
- Observing, conferencing and supporting students' own strategies (applications and procedures) and correctly developed conceptual understanding has the potential to be more powerful in supporting increased competencies in numeracy than any other pedagogical strategies that may be used.
- *For example, the Year four lesson in Technology focusses on 'Increasing Classroom Functionality'. It provides students with opportunities to use both the practical skills of mathematics as numeracy skills in their development of a model or a full size example of their design and the logical thinking skills that underpin their design and its effectiveness in solving the perceived problem.*

Conclusion

This chapter has sought to clarify the nature of mathematics and numeracy competencies in the context of an increasingly technological and globalised world. It has emphasised the political, social and cultural advantages of engaging with numeracy competencies to inform, clarify and resolve the everyday challenges and encounters in the specific contexts in which individuals live and work. It has highlighted importance of all these considerations in teaching and learning, most specifically in regards to viewing numeracy as social practice. Mathematics and numeracy are, like culture, never static; they are always evolving in response to the ways in which people need to use them in their everyday contexts. The current rate of change and technological advances has resulted in a greater need for numeracy competencies in order for people to participate and contribute fully in personal, social and civic life. It has also created a deepening awareness of the contextual uses of mathematics as numeracy competencies, and of the need to develop pedagogies that support both the ethnomathematical contextual knowledge and practices and the integration of institutional mathematical competencies as fractured, conceptual tools.

Mellin–Olsen (in Thomas, 2010) regarded literacy and numeracy as the important structures with which young people could overcome the difficulties of life and understand, build, change and shape society. If this is to be achieved, then numeracy must demand as much attention in educational contexts as literacy has received in the last 30 years. It is not only a tool with which individuals can create the society in which they aspire to live, but also a means by which Australia can maintain its economic status in the dying days of its industrial capacities and diminishing natural resources, and the increasingly global nature of Australian society. Students and young people engaged in education are the key to Australia's fiscal survival, in addition to being the catalyst for social and personal change, improvement and sustained development. However, they can only do this if they are competent mathematicians with sophisticated numeracy competencies and the capacity to use them in the societal and cultural context in which they live. This will entail providing equitable opportunities for all students, irrespective of individual differences, to gain access to the capabilities to make meaning from the mathematics education that they receive from home environments, schools and the multiplicity of encounters in their daily routines. The challenges then, are for educationalists to recognise the impact, both negative and positive, ethical dilemmas and potential of ethnomathematics in the teaching and learning of institutional mathematics (Carraher, Carraher, & Schliemann, 1985; Stillman & Balatti, 2010), to develop equitable pedagogies that allow all students to make meaning with numeracy across the school curriculum key learning areas and to make powerful links to their everyday lives.

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Teaching and Learning for Numeracy Competence

Maura Sellars

Introduction

The mathematics that has been the focus of education in schooling, and which has been referred to previously as 'institutionalised' mathematics, is the Mathematics of abstract thinking, symbolic representation and formal logical thinking. It is frequently identified in texts, policies and other documents as Mathematics with a capital M. The pure and applied forms of this learning domain represent huge social, cultural and economic capital in globalised countries. The challenge for teachers of younger students is how best to adequately prepare young learners, despite the increasing degree of diversity in Australian classrooms, to develop their understanding of the foundational concepts of this domain in practical ways, which, in turn, facilitates access to the most advanced, complex areas of mathematical thinking and problem solving. As always, it is important to understand the developmental stages of the students, and to respect the prior knowledge and experiences of mathematics and numeracy that they bring to their classrooms (Bruner, 1997; Cole & Wertsch, 1996; Duncan, 1995).

Mathematics

Pure Mathematics is a discipline area. As a formal area of study, it has rules, standardised procedures, correct and incorrect procedures and strategies which can be used to obtain correct and incorrect answers. Whilst the contexts in which mathematical activities might be undertaken can be very diverse, social and cultural diversity is woven together across contextual differences by some commonalities in

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practice (Bishop, 1998). However, this does not imply that numeracy and mathematics are not able to be practically and conceptually linked. One way in which this can be achieved is to provide supportive teaching and learning environments which promote acceptance of different ideas and strategies and collaborative problem solving, in which all students have opportunities to actively engage in explanation and reasoning around solving real problems using diverse perspectives, without the imposition of any particular viewpoint being 'more correct' or more acceptable than others (Burgh, Field, & Freakley, 2006). The teacher in these contexts interacts as a mentor, guiding rather than dominating the discussion (Dyson, 2004; Mockler, 2011; Pilling-Cormick, 1997; Prestridge & Watson, 2004). The exact nature of the interactions and learning tasks facilitated by teachers in and out of the classroom can determine the students' capabilities to see relevance and value in their mathematical learning and also establish students' competencies in linking formal mathematics to their everyday numeracy needs and interests.

Macmillan (2009) discusses categories of social contexts within which mathematical thinking and reasoning are important. Using Bishop's (1988) six mathematical actions, Macmillan opines that any type of social context can be analysed in terms of these six universal actions. These actions were labelled as 'universal' because Bishop found, in his study of communities interacting in diverse contexts, that these actions were undertaken in all cultures and social conventions. A more detailed summary of these universal mathematical actions, and the categories of social contexts which control or influence the ways in which mathematical actions are effected, is presented as Table 1.

The information contained in Table 1 not only demonstrates the relationship that mathematic and numeracy having in mutually informing each other, but it also illustrates very clearly how teachers can make learning in mathematics more enjoyable and purposeful for students. It explicitly clarifies how formal, mathematical learning can contribute meaning to everyday actions and contexts, irrespective of the age or stage of students, or of their diversity of social experiences, customs and backgrounds (Deed, Pridham, Prain, & Graham, 2012). The initial findings of a study by Beswick, Watson, and Brown (2006), which focussed on students in middle school mathematics classrooms, endorses the need for students to understand and appreciate mathematics activities not only as relevant but as personally purposeful. Beswick et al. (2006) found that, in traditional classrooms, although mathematics were considered to be important, students struggled with the complexity of the conceptual knowledge and found it difficult to identify the learning as personally purposeful.

What does this mean for you as a teacher of numeracy?

- Students make meaning and see relevance in their mathematical learning when it is associated with social contexts with which they are familiar, so new learning is more easily supported when it is contextualised.
- Every category of social context has embedded within it components that require mathematical understanding or actions, so knowing about

Table 1 A socio cultural perspective of mathematical activity (Bishop, 1998; Macmillan, 2009 p. 21)

Universal mathematical activities	Universal social mathematical contexts
Counting: determining quantities, ordering objects, distinguishing one from another in concrete or abstract terms. May also apply to frequency, events or episodes	**Political: Examples:** examining and interpreting data or statistics for political purposes. For example: election results, constituent representation, data relating to political objectives
Measuring: using formal and informal measures to determine quantities or conceptual mathematical notions that cannot be counted	**Economic: Examples**: contexts that involve mathematical skills used to determine trade deals, budget buys, budgets, monetary transactions, savings and spending
Locating: determining place and position in spatial terms either in relation to oneself, other individuals or specified objects	**Physical: Examples**: interpreting data relating to physical phenomena such as information about tides, rainfall, temperatures, fire and storm warnings in terms of social and personal safety and comfort
Designing: employing higher order thinking skills to conceptualise a plan or strategy which is abstract and symbolic and record it by various means	**Scientific: Examples**: understanding the impact of scientific data relating to nutrition, exercise, medicines, monitoring dietary requirements, intake balance and medical information relating to scientific information on personally relevant issues
Playing: the capacities to recreate or imitate social and cultural actions that have content which requires mathematical exploration. These can be imaginative, supported with concrete materials and conducted within social interaction with others. May be non-goal orientated	**Social: Examples**: determining the protocol of seating at social events or simply deciding where to sit, positioning team members in social sports in order to make the most impact for the team. Cultural issues of personal space, bodily contact and proximity
Explaining: using the symbolic, shared understandings of language to verbally explain, justify, evaluate and communicate the facts, examine the logic or conceptual understandings of mathematical ideas, experiences, events, relationships and questions	**Emotional: Examples**: deciding personal choices, choosing a team to support or someone to dance with, standards of personal dress and adornment, selection of goods and services for personal use

students' lives and experiences, which initially appears to have little or no mathematical content, facilitates a different perspective and allows teachers to deconstruct social events and teach the embedded mathematical concepts, knowledge and strategies, in order to formalise the mathematical learning.

- Students can attribute value and develop interest in mathematics that are useful in their everyday lives, so students' interests and experiences are a constant resource for teachers.
- Developing an identity as an individual who is numerate is not necessarily (or often) a linear process in the ways in which syllabus and curriculum documents are delivered.

- The importance of tracking students' mathematical progress and their capacities to use their skills and concepts to make meaning in social contexts cannot be overstated. It not only provides information about what students are currently thinking and internalising, it also gives teachers some clear information about the next stage of learning.
- Conferencing, as a one-to-one interaction with individual students about their thinking and learning, is vital because it provides teachers with rich authentic knowledge of each student in ways that exams, tests, worksheets and other pen and paper activities cannot.
- Class discussions in which participants feel safe to contribute and can engage meaningfully are important aspects of mathematical learning, as they can be mutually supportive. Other social activities such as paired tasks, group problem solving and collaborative learning assignments give students opportunities to develop their skills in adaptive reasoning, which is an area of mathematics learning which is reported to be rather neglected in Australian classrooms.
- Matching the six universal mathematical actions with the curriculum not only offers the prospect of engaging with the syllabus requirements in a novel way, it also provides a framework from which teachers can work in planning for mathematical activities and numeracy experiences.
- Pedagogical approaches are important.
- *For example, there are many lessons throughout Section Two of this work that allow students to learn within the contexts of their interests as the lessons investigate the numeracy embedded in all the areas of the primary curriculum. A popular example which is both useful in terms of students' learning for their everyday lives and for their practical use of mathematical skills and thinking is the Media Year one lesson which investigates growth. The technology used to capture the life cycle of the plant is within reach of the young learners and the pedagogy, which includes the initial organisation of the onions, also facilitates rich discussion in mathematical comparative language and mathematical thinking, as the students can see what is usually hidden under the soil in a regular garden bed.*

Supporting the Development of Personal Mathematical Capacities

If students are to reach their full potential and learn to manage both the ethnological practice of mathematics in their personal lives and in formal institution mathematics, then the teaching and learning strategies employed in identifying numeracy practices and making significant links to formal mathematics must be robust, equitable and inclusive. There are, as in other disciplines, a number of perspectives regarding the early teaching of formal mathematics, and these and others are evolving in diverse Australian classrooms (Artigue, 2010; Bobis, 2013; Bobis et al., 2005; Bobis & Mulligan, 2010; Booker, 2011; Buschman, 2001; Clarke, 2001; Clarke & Clark, 2004; Hennessey, Higley, & Chesnut, 2011; Mukhopadhyay & Greer, 2010; Mulligan, 2010; Schoenfeld, 2002; Stacey, 2010; Suh, 2007; Watson, 2008). For this writing however, it is sufficient to note that mathematics in the primary, and indeed the early, years of secondary schooling needs to be based on the symbolic representation of practical mathematics and their use as numeracy competencies (Sullivan, 2011a, 2011b). The considerations that need to be made are mainly in terms of developmental capacities (Bobis, 2013; Bobis et al., 2005; Sullivan, 2011a, 2011b) and presenting mathematics in ways that allow students to understand, 'read' and use symbolic representations as a literacy that is deeply embedded in patterns and relationships, one which can be utilised to record and explain everyday events (Siemon et al., 2013). An important aspect of teaching mathematics, therefore, is to develop and explore numbers and other mathematical constructs in relation to each other and in relation to how they inform everyday life and the other subject areas in the school curriculum (Baker, Goesling, & Letendre, 2002; Baker, Street, & Tomlin, 2003; Ferme, 2014; Fox & Surtees, 2010).

The model developed and presented below has been designed specifically to highlight components of teaching and learning in numeracy that are important considerations but are frequently neglected when discussing the ways in which numeracy capacities can be supported and strengthened. The very heart of the integrated framework reflects the personal nature of numeracy that is cultivated in the specific, particular social and cultural circumstances and situations which each individual inhabits, whilst the entire paradigm is enclosed in the wider context of the civilisation and culture to which individuals belong. In addition to the work of Baker, Street and Tomlin (2006) the work of other theorists has been incorporated to illustrate some of the relationships and tensions between mathematics and numeracy. These tensions include the ways in which mathematics proficiencies can be developed to support activities in numeracy (Sullivan, 2011a, b) and the principal actions that teachers must incorporate into their lessons to support the application of mathematical notions and strategies in mathematical activities becoming accessible and useful in numeracy (Watson, 2011). It also includes the Four Resource Critical Numeracy Model (Watson, 2009), based on (Freebody & Luke, 1990, 2003) four roles of the reader. The parallel model developed from this is designed to be used to encourage students to make meaning of learning in mathematics in ways that support numeracy across the wide range of curriculum subject areas and in relation to students' own ethical decision-making (Fig. 1).

Five Strands of Mathematical Actions

Sullivan's (2011a, b) five strands of mathematical actions are based on the work of Kilpatrick and associates in 2001 (National Research Council (U.S.) Mathematics Learning Study Committee, 2001) and the subsequent refinement of these by

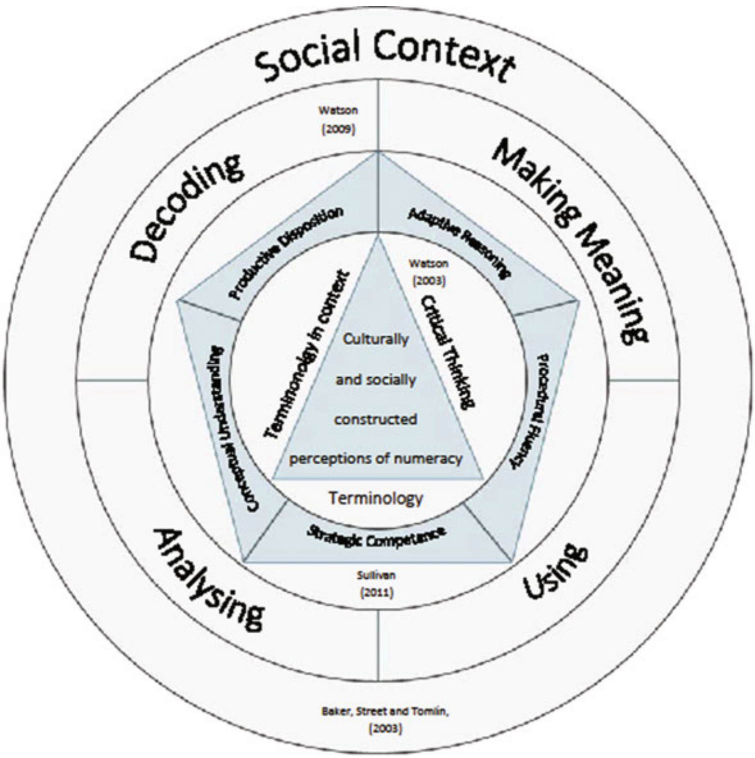

Fig. 1 A Framework for supporting personal numeracy

Watson and Sullivan in 2008. They describe the types of actions that support effective student learning in mathematics. Conceptual understanding, the first of the mathematical strands, highlights the need for students to be given the opportunities to understand not only what they are required to do in mathematics and *how* to do the tasks, but also to be able comprehend the mathematical concepts that are being engaged with, the structure and purpose of the operations being utilised and the relationships that are simultaneously being investigated, explored and discovered. The foundational theories that underpin this strand of mathematical action are the cognitive theories that support the development of '*robus*t' knowledge in the learners' neural networks. This is the type of well-understood knowledge that is connected to other learning in the brain's learning networks and, because of these strong neural links, is able to be accessed and to be 'transferred' into new learning contexts and experiences (Blakemore & Frith, 2005; Suarez-Orozco & Sattin-Bajaj, 2010). Knowledge that is learned and remembered without full understanding is considered to be *'inert'* knowledge because it is not linked meaningfully to other knowledge and is not able to be transferred easily into new learning contexts. This type of knowledge is primarily used in the same ways and in learning tasks and contexts that are overtly similar to the tasks in which it is first learned.

The second of these strands is identified as procedural (National Research Council (U.S.) Mathematics Learning Study Committee, 2001), or mathematical fluency (Watson & Sullivan, 2008). The term that is preferred by Watson and Sullivan is probably most useful, as it refers not only to the capacity to carry out mathematical procedures accurately, efficiently and correctly, but also to the capacity to recall factual knowledge and concepts readily as they are required to complete mathematical tasks. This strand may appear to be somewhat contradictory at first glance, as the essential skill is rapid recall of mathematical learning components. However, this fluency is not based on rote learning; it is achieved in the practice of repeated rehearsal, during which students have opportunities to explore and implement their learning in familiar and in new contexts and tasks, and during which they can deepen their understanding. This strand of mathematical learning is not linked to rote learning.

Strategic competence is the strand of activity that is most easily engaged with when students have achieved some conceptual understanding, and it is supported by mathematical fluency because it is the strand that is focussed on problem solving. The capacity to solve problems involves students engaging with analytical cognitive processes. To solve problems, students must first identify the problem and then strategically use the procedures that they have learned and understand well to solve it, or strategically use their mathematical knowledge to invent or devise a series of actions to resolve the issue. To do this effectively, students need to understand what they have learned about mathematical concepts, procedures and relationships, and then use this knowledge in new or unforeseen contexts and circumstances. This process can be considerably facilitated by a high degree of mathematical fluency. It is also made more accessible by the fourth strand of mathematical actions, adaptive reasoning.

Adaptive reasoning requires students to engage with higher order thinking. It involves developing competencies in logical reasoning, explanation, justification and reflection. Students need to be able to explain how they devise mathematical plans for problem solving. In order to do this effectively, students need opportunities to work creatively and constructively during their mathematical learning tasks. They need to participate in leaning tasks that promote discussion, conjecture and sharing of ideas and strategies, as this is the means by which students' mathematical thinking and reasoning can become a shared experience and provide the occasions for reflection, justification and evaluation that cannot be experienced during solitary, routine mathematics tasks that are concluded with an acknowledgement that students have or have not found a correct answer.

The final strand of the mathematical actions that are discussed by Sullivan (2011a, 2011b) is productive disposition (Watson, 2008), or a habitual inclination (Watson & Sullivan, 2008) to perceive mathematics as useful, productive and worthwhile. This strand acknowledges the impact of emotion, most especially positive emotion, motivation and positive engagement. The impact of emotion on learning is well documented (Gardner, 1993a, 1993b; Goleman, 1995; Souza, 2010) but not extensively explored by Sullivan (2011a, 2011b). This is interesting because of the links to the personal, social and cultural aspects and expectations of students, the diversity of learning preferences (Gardner, 1993b; Sternberg et al., 2000; Sternberg, Jarvin, & Griforenko, 2000; Sternberg & Kaufman, 2006) and the unique wiring of each individual brain (Coch, Fischer, & Darwin, 2010; Medina, 2010), which result in teachers having to know their students and their learning preferences, understand different ways of interpreting, understanding and using numeracy (Street, Rogers, & Baker, 2006), and then design programs of work based on the students' prior learning and with which the students can engage. This mathematical strand may not have been thoroughly extrapolated by Sullivan because he felt it was not as 'mathematical' as the other strands; however, it is argued here that this strand would be vital to any authentic learning context as, without some degree of interest (Reese, 1998; Sellars, 2008), students do not engage positively or meaningfully, nor do they work productively, in any area of learning. Productive disposition may be especially important in mathematics because of the specific difficulties that are experienced by some learners such as dyscalculia (Landerl, Bevan, & Butterworth, 2004; Munro, 2003) and maths anxiety (Sheffield & Hunt, 2006/2007).

The perceptions relating to the importance of this strand are compounded by the mathematics curriculum document proficiencies (ACARA, 2009 p. 6). These are obviously developed from the same source (ACARA, 2009) as Sullivan's strands of mathematical actions, and this is noted by ACARA. However, the strand identified as productive disposition does not appear, despite the importance placed, in all teaching and learning contexts, on positive attitudes to support successful learning. The proficiencies, as adapted by for the National Curriculum in Mathematics (ACARA, 2009), are as follows:

Understanding, which includes the building of robust knowledge of adaptable and transferable mathematical concepts, the making of connections between related concepts, the confidence to use the familiar to develop new ideas, and the understanding of the 'why' as well as the 'how' of mathematics.

Fluency, which includes skill in choosing appropriate procedures; carrying out procedures flexibly, accurately, efficiently and appropriately; and recalling factual knowledge and concepts readily.

Problem solving, which includes the ability to make choices, interpret, formulate, model and investigate problem situations, and to communicate solutions effectively.

Reasoning, which includes the capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising (ACARA, 2009).

What does this mean for you as a teacher of numeracy?

- Ensuring that students have sound conceptual understanding of mathematical language, procedures and numbers allows students to develop new ideas based on previous learning experiences.
- Making explicit linkages and connections and discovering and exploring number and other conceptual relationships helps students to develop robust knowledge that is easily transferred from familiar to unfamiliar contexts and problems.

- Basing mathematical fluency on deep understanding and avoiding rote learning allows students to respond to appropriate cues and prompts because they then have the capacity to work out what may have been forgotten.
- Facilitating social interaction and dialogue in mathematical problem solving allows students access to each other's thinking, investigations and processes for problem solving.
- Having the expectation that all students participate in the activities, including the discussions, sharing and reflections, prompts students to develop a community of learners when all ideas are acceptable and are discussed without prejudice or favour (Burgh et al., 2006).
- Avoiding asking students to complete tasks that are overly simplistic or unnecessarily repetitive, and not requiring students to explain their procedures, justify the answers or explain their work in discussion.
- Providing adequate time for sharing ideas, discussing, debating, collaborating and reflecting.
- Engaging with students in conferences, discussing with them their individual strategies, justifications and processes.
- Giving regular feedback that is meaningful for the students in terms of what is progressing well, discussing areas that are problematic or may be the next step in their learning and providing plans that address these; so students develop confidence and receive support with their learning and develop positive attitudes to learning in this area.
- Eliminating consumable materials that require students to fill in boxes with answers and texts that necessitate working through complete pages of operations that have the same degree of complexity, the same strategies and little differentiation in presentation.
- Using materials, resources and assessment designs that allow students to individually show what they know, not what they do not know.
- Creating assessment items and everyday tasks that resonate with students' own numeracy practices; that require personal, cultural and social responses; and that engage students in the logical skills described in adaptive reasoning.
- Providing safe, non-competitive learning environments in which students gain an understanding and an appreciation that mathematics is relevant, useful and interesting, where mathematical competencies are not judged on pages of ticks and crosses.
- *For example, the History lesson designed for Year Three, 'Using an abacus to make a personal time line' integrates some very understandings about data representation, yet is reliant on the students' own understanding of chronology, and their capacities to organise their personally selected events successfully as an interactive data display from which other mathematical information can be retrieved.*

Mathematical Thinking

Siemon et al. (2013) indicate that there are at least four types of mathematical thinking and activity. Although these are not, in practice, isolated one from the other, but rather are integrated in a wide diversity of tasks, it is important for educators to specifically plan for activities which engage each type of thinking. First, and most popular, are exercises. These are activities like algorithms, which have no context or limited context. Pages of these are given to students under the guise of developing fluency. Many worksheets and pages in mathematics text books have exactly this type of activity and little else. Second is problem solving, one of the most difficult tasks for some students as the contexts and construction of these is often not readily able to accessed by specific groups of learners. There are two types of activity to be identified here. They both have the same characteristic in that their answers are not obvious and there are many ways by which their problems can be solved. Word problems are commonly written in ways which describe a common experience for students at the various stages, for example sharing at parties, going shopping, etc. In order for the students to engage with the thinking required here, they need to be able to identify the appropriate operations (not be told that these are all division problems, for example) and apply them accurately and meaningfully to contribute to solving the problem, which may require the students to complete more than one step in order to solve the problem (Iii & Ford, 1991). There are also problems that are all numerical, without words. An example may be to find the radius of a circle, but the only information supplied means the students have to complete several operations in order to solve it. Neither type can engage student thinking successfully if the steps or strategies are thought through for them, not by them independently. Both these types need the students to be proficient in reasoning, especially adaptive reasoning, because they have to adapt their known strategies to the specific contexts of the new problems to be solved. Neuroscientific findings have demonstrated that the impact of verbal instruction is very limited in terms of students transferring what they know from one context to another. The critical component of this learning is that students know what the example is illustrating so they can identify the problem solving rules independently (Lee, Fincham, Betts, & Anderson, 2014).

The third, investigating, is possibly the most neglected of the mathematical thinking and activities, yet it is critical to the development of understanding relationships and patterns in mathematics. These are the types of tasks that do not have questions to be solved. They are activities that promote the search for patterns and relationships, and encourage students to find these for themselves; using the specialising-to-generalising thought process in order to establish rules or relationships for themselves and not being actually told these by the teacher. Finally, there are modelling tasks and thinking, which are essentially embodied learning. These are not the same as modelled activities in Literacy. Mathematically, these are the activities that are 'modelled' by using algebraic expression to express the relationships between the components of the problem to be solved. This is the most cognitively complex of the activities outlined. Engaging with these activities requires complex understanding of the generalized nature of algebra, the use of pronumerals and the capacity to solve problems using abstract terms.

What does this mean for you as a teacher of numeracy?

- Mathematical thinking and learning is an extremely complex cognitive activity.
- Students with robust, developmentally appropriate executive function skills have increased potential to achieve mathematically.
- Electronic games and board games that engage students with non-symbolic and symbolic representations of larger and smaller quantities engage both the inherent capacities relating to awareness of magnitude that babies are born with, and the representation of precise numbers as symbols.
- Students from different language backgrounds may have difficulties with the ways in which numbers are expressed in words in the English language.
- The four different types of mathematical activities and thinking are of equal importance in mathematical competence. They are neither exclusive nor exhaustive domains. For example, it may be impossible to solve a modelled activity without using algorithmic and algebraic knowledge, and the same task may involve investigating patterns and relationships in several mathematical areas.
- It is important not to dwell exclusively on exercises. This is because the creation of problem-solving strategies in these divergent tasks engages parts of the brain that are not ever required to function together as neural circuits in the less creative, more convergent contexts of exercises.
- *For Example, the Year Six lesson in Technology, Designing an Interactive Game, requires students to use their mathematical thinking and knowledge in combination with their creative capacities to design an interactive games per the criteria that is stipulated. This activity can be implemented with the minimum language difficulties as the criteria can be visually or concretely represented and the mathematical language modelled and investigated in this way. The problem solving and mathematical thinking for this activity requires students to not only to know and understand the mathematical content but also to have the executive function skills of taking initiative, persevering with the task and checking for accuracy, and monitoring their own thinking and emotional responses. This is a task which requires complex mathematical and creative thinking. The very detailed lesson in Media for Year Six, Moveable Triangles, provides a good introduction to this type of interactive construction and emphasises the importance of angles in the movement embedded in these tasks.*

Conclusion

This chapter has focussed on the development of sound mathematical skills, knowledge and concepts that formalise and symbolically represent students' learning experiences, both in and out of school environments. It explored the complexity of influences, social, neural and psychological that impact students' concepts of both the nature of mathematics and the nature of the learning process that is required for gaining mathematical proficiencies. It has suggested what these notions might mean for teachers in classrooms, their pedagogical practices in relation to mathematics and their opportunities to engage all students positively in the tasks that support successful learning in mathematics. The complexity of learning in mathematics is explored through the various models of mathematical actions, mathematical activity and the brain; and also the investigation of the various types of mathematical thinking and activities. However, this is just one side of the coin. The other is the numeracy: mathematics in action in everyday personal life and activity.

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The Mathematical Brain

Maura Sellars

Introduction

The development and discussion of a clearer picture of the impact of sound pedagogies and a Model of Personal Numeracy (Fig. 2.1) that take into consideration various differences in student understanding and learning have been targeted at the teaching and learning of mathematics and numeracy as focus curriculum areas. The Model of Personal Numeracy may even contribute to an understanding of the complex, intertwined numeracy and mathematics relationship. However, that does not necessarily mean that all students find it easy to develop skills in mathematics or numeracy or even that teachers find this a simple discipline to teach effectively to every child. There are always personal differences amongst the students which include diverse learning competencies and differences, attitudes and values and other, non-specific characteristics that somehow get in the way of successful learning in these areas for individual students. Amongst these individual traits that may baffle or frustrate both the learner and the facilitator of the learning are some extreme social and cultural conditions and some biological, but frequently unseen and only recently investigated barriers to learning in mathematics and numeracy. Many of the social barriers are linked to extreme poverty and its impact on affect, cognition, academic confidence and subsequently, academic achievement.

Others may be less socially mediated in terms of socio-economic status but may be created by social pressures and expectations, perhaps in classrooms and in the communities, or as the result of certain predispositions in personal development and confidence. Many of the more recently recognised physical barriers relate to the brain and its ways of working. These are only able to be investigated in terms of the findings of a relatively recent science which has facilitated investigation into the brain and its functional capacities; that of neuroscience. It is important that each of

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these categories of difference that have the capacities to impact negatively on learning in mathematics and numeracy as dedicated aspects of classroom curriculum be discussed and evaluated in relation to supporting each student's efforts to become numerate and to fulfilling the responsibilities that every teacher has to find ways to scaffold and to encourage competencies this particular literacy. This literacy (quantitative literacy) pervades every aspect of the world in which students interact currently and will inherit in the future.

The Workings of the Brain in Numeracy

A consideration of the nature of the brain and how it works may appear to be outside the scope of teachers' professional learning but that may change with the current development of neuroeducation or a focus on brain, mind and education (Ansari, De Smedt, & Grabner, 2012), particularly with reference to developing numeracy competencies and mathematical skills (Butterworth & Walsh, 2011). Additionally, the work of Mc Gilcrest (2009), which posits that the right and left sides of the brain have different functions, may explain in part why teaching and learning in mathematics has been thought to be a separate area of study and is rarely integrated into other content domains to provide a holistic view of mathematical thinking and understanding. In arguing that the western world has been dominated and developed by centuries by the detail of left brain thinking, Mc Gilcrest (2009), may be explaining the dominance of mathematical teaching and learning which focusses more on the learners capacities to work with number calculations and formulae, rather than investigating the breadth and depth of the relationships that mathematics has with every person in their everyday lives, thus placing mathematics in the bigger picture of numeracy skills, cognitive capacities and reasoning processes that develop flexible thinking and promote the skills of effectively developing and using students' working memories.

So, an understanding of some very basic brain facts can be very helpful as teachers attempt to understand students' own constructions of mathematical understandings and numeracy competencies. There is not necessarily the need to know and understand the physical structure and the chemistry of the brain in a medical sense but some very basic understanding can be useful. The brain is the site of all cognition (the ability to acquire knowledge by using reasoning, perception and other mental faculties) and understanding it is an important aspect of knowing how students learn best and how teachers can effectively prepare and implement appropriate learning tasks to develop competencies in numeracy. This is despite the fact that only a tiny percentage of brain research is relevant in educational contexts (Jensen, 2005). At times student learning appears to happen instinctively and with little apparent effort. This may be why, as yet, studies into the workings of the brain are not having a significant impact on educational systems, learning environments or curriculum development. Another reason may be that the entire picture of how learning takes place is not yet available (Jensen, 2005). Despite this, findings from neuroscience have been used to contribute to significant advances in the teaching of academic skills in mathematics and to establish the interdependence of emotion and cognition (Immordino-Yang & Feath, 2010; Souza, 2010). It is known that from the very first cell division foetus in the womb there is an intricate balance between genetic inheritances and environment. This has clear implications for brain development.

Lipina and Posner (2012) found that conditions of poverty such as overcrowding, hunger, stress and fear of physical harm had could have a negative impact on brain functions which support academic learning, as could non-stimulating environments. This is because the brain is literally created by experiences. All types of sensory experiences, visual, auditory, tactile, physical, gustatory and olfactory, create imprints on the brain which are represented as a series of images (Suarez-Orozco & Sattin-Bajaj, 2010). The brain even starts life with capacity for emotional responses, which can later be educated to respond appropriately to moral and ethical challenges. These emotions and feelings have images that are based in the body itself as opposed to the responses elicited by outside stimuli. 'Images are the currency of the mind' (Suarez-Orozco & Sattin-Bajaj, 2010: 61) and the owner, interpreter and 'comprehender' of the mind is the 'self'.

Equally important is a cursory understanding of the brain's structure. There are four lobes in the brain; the temporal, frontal, parietal and occipital. The outermost layer of the is called the cerebral cortex and covers the cerebrum, and the front part of the brain (Blakemore & Frith, 2005b). The cerebral cortex is often termed 'the grey matter' and is the most highly developed part of the brain. It is the critical component in the learning process. It is divided into left and right hemispheres. There is, as yet, no complete understanding of the precise function of each of the two hemispheres of the cerebral cortex, which are joined by clusters of nerve fibres known as the corpus callosum and the anterior commissure, which also facilitate communication between the two hemispheres. However, it is known that different parts of the brain are used, either independently or more usually in coordination with other parts of the brain, for different types of learning (Gardner, 1993a). For example, the hippocampal system, which is located in the temporal lobe, is concerned primarily with learning facts. The cerebellum and the basal ganglia, which can both be found under the cerebral cortex are the locations responsible for the development of skills. Blakemore and Frith (2005b: 78) indicate that the learning required for reading and writing related skills are located in three areas of the brain. Unfortunately, the areas of the brain that process mathematical thinking are not as easily identified (Davis et al., 2009) and this has the impact of limiting what teachers know about how students construct mathematical skills and numeracy competencies.

What is known is the human brain has innate number sense, concepts of discrete whole numbers, the capacity to distinguish a correct from an incorrect answer when the scenario involves arithmetic and small whole numbers and that numbers and arithmetic beyond three require the use of language (Devlin, 2010: 164). Although there is no one area of the brain that is responsible for all the different types and components of learning and processing in mathematics, the parietal lobe is the lobe associated with spatial representations, sense of direction, locating objects in time and space and with numbers and their relationships. Davis et al. (2009) also found that the parietal lobe became more specialised for computing arithmetic tasks with as students became older and entered adulthood. Exact calculations also appear to be processed in this area of the left hemisphere but the capacity to process approximation of number appears to be located in a different area of the brain altogether, which is in the right hemisphere. Although the brain actively seeks and recognises patterns and both hemispheres are able to compare numbers, only the left hemisphere can add and multiply. Interestingly, there still exist some difficulties in locating the exact sites of some other 'non mathematics specific' areas of learning. For example, theorists present some differences in their understandings of where the skills of reading music are located. Jensen (2005) indicates that reading music activates both sides of the brain. Blakemore and Frith (2005a, b), however, report the findings of a study that located these skills in the same area of the parietal lobe that facilitates spatial awareness.

In the development of quantitative thinking itself, as indicated, infants have been proven to possess innate number sense in terms of distinguishing quantity (Berninger & Richards, 2002; Lipina & Posner, 2012). The difficulty is however, harnessing that potential. As Devlin (2010: 163) comments

Mathematics teachers—at all education levels—face two significant obstacles

- We know almost nothing about how people do mathematics.
- We know almost nothing about how people learn mathematics.

Berninger and Richards (2002: 196) are able to add some information regarding the beginnings of mathematic thinking. They describe the notion of 'true counting' where children are able to use one-to-one correspondence as an indication that they have created an 'internal' number line and thus have started the process of rudimentary and complex mathematical thinking such as 'place value, the concept of infinity, negative numbers and prime numbers'. There are however, disputes over the location of this in the brain (Lipina & Posner, 2012). Berninger and Richards (2002) suggest that this thinking can also be supported by the use of an external number line to use as a tool. They assert that eventually, most students develop and learn to manipulate more than one number line and this facilitates the control and interaction of multiple quantitative dimensions at the same time. Importantly, they indicate that for these mental models of number lines to become more complex there must be present the capacity for 'crosstalk' between the various parts of the brain which perform different functions. Using current research, Berninger and Richards (2002: 205–206) have identified possible sites of diverse mathematical activity. Unfortunately, a number of mathematical functions that are critical to the development of numeracy competencies are still listed on this table as 'unknown'.

However, more recent research has begun to help close this information gap. Cragg and Gilmore (2014) summarised the various findings from diverse studies which involved investigating any potential relationship between strategies to strengthen specific cognitive capacities in the executive function domain (see Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Bernstein & Waber, 2007; Dendy, 2002; Isquith, Crawford, Espy, & Gioia, 2005; Meltzer, 2007; Moran & Gardner, 2007; Sellars, 2009). The studies they examined involved participants in various ranging from 5–12 years old. They indicated that they found strong evidence that the executive function capacities of working memory, flexible thinking, impulse inhibition and self-monitoring were all important capacities in children's mathematical development of facts procedures and concepts. The particular impact and importance of each of the cognitive capacities varied amongst the students according to development stage, activities undertaken and the mathematics proficiency of the individual students.

The degree of neurological activity associated with the cognitive capacities of working memory also proved to be an accurate predictor of the ease with which students could learn new mathematical knowledge. They concluded that the precise ways in which these domain general cognitive skills facilitated improved mathematical understandings was not entirely clear at this time, however, if students' mathematical progress were assessed in terms of their achievement in factual, conceptual and procedural knowledge instead of the standardised testing that is currently implemented, more critical information would become available to support and inform classroom practice. As both mathematical ability and executive function skills improve throughout the developmental stages of individual growth, another important issue for this research was to pinpoint how the relationship of these cognitive capacities of executive function impact differently at assorted ages and in different mathematical domains. Working with college students to determine the relationship of domain general cognitive capacities (executive function skills) and domain specific skills (mathematics, in this case complex arithmetic), Ashkenazi, Golan, and Silverman (2014) found that strong executive function capacities can compensate for poor mathematical acuity in complex arithmetic tasks.

Other investigations into working of the brain promise to be of benefit to mathematics educators in the early stages of learning. Until very recently, it has been difficult for neuroscientists to pinpoint exactly which areas of the brain were involved in mathematical activities. However, findings from neuroscience research has been able not only to identify regions of the brain that are involved in mathematical activities, but have recently ascertained the functional circuits that work together to facilitate mathematical learning (Evans et al., 2015). Bassett, Yang, Wymbs, and Grafton (2015) also investigated the importance of the neural connections and distributions in the brain during learning for therapeutic, non-invasive purposes. This work also has potential for enhancing teaching and learning. Neuroscientific findings have also established that board games and electronic games that have both symbolic and non-symbolic (dots or drawings to indicate magnitude) are critical for students at risk of developmental dyscalculia or a typical numerical development (De Smedt, Noel, Gilmore, & Ansari, 2013), that physically doing activities supported the development of complex abstract representations in number activities (Link, Moeller, Huber, Fischer, & Neurk, 2013) and that the ways in which numbers are expressed in different languages affects the ways in which adults process arithmetic (Lonnenmann & Yan, 2015).

The fact that there are still aspects of thinking that not able to be located in the brain but are required for competency in mathematics and numeracy can be an important factor that impacts on teachers' efforts to support student learning. To further complicate matters, all the components of the 'computing' brain (the mathematical parts of the brain that are identified) do not develop at the same pace (Berninger & Richards, 2002; *The Josset Bass Reader on the Brain and Learning*, 2008). It is suggested that genetic, social and cultural diversity may have an impact on the maturation of various parts of the brain and on the associated capacities to function effectively in relation to other elements. A number of competencies that are required to coordinate together for effective processing; such as capacity for sustained attention, visual skills and the coordination and physical skills of writing; may impact on the capacities of the components of the computing brain to work together effectively or not. It is also possible that there is a mismatch of competencies. For example, children know more about the number system than they can express using the standard symbolic notation or that students appear to have achieved successful prior learning in regard to number but they actually have factual but no conceptual understanding of what is required. The other influential factor is that students may have 'wiring anomalies' (Lipina & Posner, 2012: 209) that need to be investigated.

What does this mean for you as a teacher of numeracy?
While the brain is very complex and is still being investigated, there are some clear implications for professional practice. These include:

- An understanding that all experiences, good or otherwise are part of creating the brain. Successful learning experiences and those that are not successful have equal impact.
- There is limited specific knowledge relating to how individuals learn or do mathematics, making the work of the mathematics teacher less informed in terms of how the brain functions exactly in their area of knowledge.
- As different parts of the brain exhibit a readiness to learn at different times, it is important that learners are encouraged to undertake appropriate tasks. It also means that tasks which appear too difficult are reserved until the part of the brain that facilitates this learning is ready to be active in the learning process. Students need to be encouraged to believe that they will achieve various tasks when they are ready and not to suppose that they will never be good at the area that they are finding difficult at any moment in time.
- Understanding the concept of one-to-one correspondence is critical to mathematical thinking.
- Relating new ideas to previous knowledge is very important in the learning process. Learning occurs all the time, so learning outside the

classroom context is an important source of reference on which to base related, new learning as the synaptic occurrences make the learning easier on that pathway.

- Sequencing is important. In order to give students the best opportunity of learning successfully, ideas and knowledge, strategies and procedures should be taught in as logical, ordered, relational fashion as possible, even though all learning is not linear.
- Because the brain changes in structure with each new learning experience (Berninger & Richards, 2002). It is often necessary to teach the same concept in different ways because novices' (students) brains are organised differently one from another and from their teachers. This is because of the density of learning experiences in the brain of the teacher which is not yet present in the brain of the learners. It is also because experiences are personally mediated and linked, and, together with the unique patterns of wiring in each individual's brain, are organised, stored and linked in ways that are specific to the individual.
- The brain does change in response to learning. However, as everyone is 'wired' differently, it is safe to assume that none of the students will experience exactly the same changes in organisational structures, despite the common attribute known as 'brain plasticity (Souza, 2010)'.
- Given (2002) proposes that the brain is organised into five learning systems, each of which impact on and interact with each other. She names these as the emotional, social, cognitive, physical and reflective systems. Difficulties in any one or more of these can affect the brain's capacities to orchestrate the finely tuned communication that is necessary for even simple mathematical tasks.
- Parts of the brain usually coordinate with each other during the learning process.
- Only one part of the brain is utilised when learning is about learning facts. This means that other types of learning are important in any lesson plan.
- Students cannot always explain how they known various aspects of mathematical understanding as number sense is part of the brain's function, so they may just know that what they are seeing or doing is correct.
- External tools (concrete materials and number lines, etc.), can support thinking in counting and related conceptual constructs.
- *For example, the Year Three activity in Visual Arts requires students to reflect on their previous learning and select anything they feel is relevant to the given task. The relevant information may include conceptual knowledge about shape, relative quantity and the appropriate vocabulary to describe and discuss this knowledge. This recall and reasoning process is identified as a cognitive activity. In the task, the students need to actively deconstruct and reconstruct an image by interacting with physically as well as cognitively. Students find this easier when they are engaged positively (Fredrickson, 2001) and this task promotes social*

interactions as students are encouraged to work together to share their creative ideas, to discuss the metalanguage, to investigate using trial and error and to continually make decisions about the results based on prior learning and on the learning that is taking place. Any mathematics activities where students are physically manipulating materials, investigating, discussing prior knowledge and language in groups, and where they are not threatened by fear of failure or criticism has the potential to engage all the proposed learning systems (Given, 2002).

Impact of Individual Differences in Brain Development on Numeracy

Differences in environment impact on the brain's capacity for learning. One of the most powerful environmental differences can be related to socio-economic status and the impact that living in poverty can have on the brain (Janus & Offord, 2007) considering the substantial impact of home numeracy experiences on later learning in mathematics (Kleemans, Peeters, Segers, & Verhoeven, 2012; LeFevre et al., 2009; Manolitsis, Georgiou, & Tziraki, 2013) and the advantages gained in terms of students' scores in primary mathematics by children who have the opportunities of engaging with numeracy experiences at quality preschools (Melhuish et al., 2008, 2013). Limpina and Posner (2012) reported that students from low socio-economic backgrounds who participated in their study did not have a great an understanding of quantity as students from other, more financially secure backgrounds. Given the importance of understanding quantity to the beginnings of mathematical thinking, there are clear implications for these students in relation to their capacities to succeed in mathematics at school as the Australian Early Development Index, which is implemented at age five, has been shown to be a reliable indicator of student performance in mathematics during the primary school years (Brinkman et al., 2013). However, Limpina and Posner did also find that early training in board games, computer games and manual activities that developed the students' capacities in numerical quantities had the capacity to mediate the impact of this deficiency and lessened the risk of the students failing in primary school mathematics (Ramani & Seigler in Limpina & Posner, 2012: 8 Interestingly, results from another study reported by these authors found that the positive impact on student learning was restricted to one aspect of number sense competencies; their capacities to compare numbers and words (Wilson et al., in Limpina & Posner, 2012: 8). Despite the differences in the findings of these two studies, a third numeracy intervention study conducted across five kindergarten classes in a low socio-economic school indicated that the students 'at risk' in numeracy who participated in the programme benefitted in terms of all the aspects of numeracy sense (Sood & Jitendra, 2013).

The findings that students from low socio-economic environments had less well-developed concepts of quantity may be explained in terms of limitations of language development (Walker, Greenwood, Hart, & Carta, 1994) or other circumstances associated with low socio-contexts. In addition to these language considerations, Limpina and Posner (2012), in their investigations of low socio-economic pre-schoolers also discovered some very interesting cultural differences. The students who were Chinese native speakers used different parts of the brain to complete the same tasks as those who were native English speakers. This anomaly may be the result of social, genetic or experiential differences and is as yet, unexplained. It is known that the brain needs, for example, like other parts of the body, to be kept healthy through adequate nutrition (Taras, 2005). The impact of overcrowding, hunger, mental stress and perhaps fear of physical harm has the potential to have a negative influence upon the development of the brain during childhood and later in life (Lipina & Posner, 2012). The lack of complex, rich environments for children to interact within may alter the brain's potential to adapt easily and meet the challenges of new contexts. Even sleep deprivation can have a severe negative impact on the brain and learning as it interferes with cognition, decision-making, reasoning and innovative thinking (Blakemore & Frith, 2005a). It seems that, during sleep, the brain reactivates the regions that are used for learning during day and interrupted or poor quality sleep interferes with that regenerative learning process.

The quality of the learning environment is another area in which contextual variation impacts on students' capacities to learn effectively. Recently, a focus on positive learning environments (Seligman, Ernst, Gillham, Reivich, & Linkins, 2009; Seligman, Park, & Peterson, 2005) has indicated that students achieve more successfully if their learning contexts are positive and supportive (Noble & McGrath, 2008). This evidence supports the work of Souza (2010) that indicates that the human brain is unable to think unless it is in a 'safe' environment and of Given (2002), who has explored social and emotional learning systems and their influence on each and the other systems that are focussed on learning. This research is also validated by the findings of researchers in other disciplines associated with learning and education. These include the work of Fredrickson (2000, 2001) whose '*Broaden and Build'* model was developed from her research that clearly indicated that the capacities for the cognitive skills associated with problem solving and creativity were able to be enhanced by the provocation of positive emotions. The importance of the influence of emotions on the potential for the successful development and access of cognitive capacities has been well explored in the contexts of emotional intelligence theories (Bar-On & Parker, 2000; Goleman, 1995; Mayer & Salovey, 1997; Mayer, Roberts, & Barsade, 2008). It has also been a component of the exploration of the intrapersonal intelligence domain of Gardner's Multiple Intelligences Theory (Gardner, 1993a) which demonstrates the effect that the positive engagement trait of executive function has, not only in relation to effective cognition, but also in regarding self-regulation and monitoring of behaviours. Teaching and learning in positive contexts and environments certainly appears to support effective cognition. In contrast, one of the most widely recognised consequences for students who do not enjoy teaching and learning in mathematics is the degree of anxiety that was associated with this subject area.

The investigations that were carried out by Limpina and Posner (2002) revealed that, as the tasks the pre-schoolers were asked to complete became increasingly complex, the English native speakers activated parts of the brain associated with anxiety and negative effect. The Native Chinese speaking pre-schoolers did not. Whilst the reasons underpinned these differences are yet to be discovered, if the variation were to be identified as a dissimilarity in preschool education or training, that certainly would have significant implications for teachers and their mathematical pedagogies. It could also lead to the routine screening of students' brain activities and anxieties after they had participated in intensive teaching programmes designed to increase their numeracy skills (Cohen Kadosh, Dowker, Heine, Kaufmann, & Kucian, 2013). However, whilst this will certainly be useful teachers and their students, it may reveal that certain groups of students are more prone to mathematics anxiety than others and that ways to support these students in regular classrooms need to be developed from research and able to be implemented by teachers in the contexts of their regular classroom practices.

Sheffield and Hunt (Sheffield & Hunt, 2006, 2007) have defined maths anxiety as feelings of tension, apprehension fear or anxiety and have noted that maths anxiety is not confined to students studying arts subjects, it is also found in students who are studying in areas that require specialised mathematical knowledge. The impact of this anxiety is twofold. First, students may avoid mathematics and fail to develop sufficient conceptual understanding on which to build robust knowledge. Second, they feel so anxious whilst completing mathematical tasks that their working memory, on which many complex calculations heavily rely, becomes distracted and affects their performance. Westwood (2008: 11) whilst discussing the importance of capitalising positively on children's interest and competencies in numeracy during their early years, stresses the role of the school in fostering learning in this area or by 'snuffing out' any positive student inclination by engaging students with mathematics in ways in which they experience failure. This situation can be compounded by the expectation that students engage with mathematics homework. Lange and Meaney (2011) reported incidences of severe emotional trauma in cases where parents are unable to support students with their mathematics homework. They identified a number of reasons why this might occur. They suggested that parents did not always have the skills and knowledge to support their children or that perhaps that the means by which the parents explained the concepts, strategies or knowledge was different to the way their children were learning at school. Either of these situations could lead to emotional trauma for both the parents, who had been placed in the role of teachers as mathematics as a discipline, and for students whose brains associated learning in mathematics with failure, distress and negativity. A further disadvantage was that, by engaging in activities that were based on formal mathematical procedures in the home, the students were not able to use this time to engage with their parents in order to explore genuine opportunities to become more numerate.

What does this mean for you as a teacher of numeracy?

- Perhaps the most important overall finding of neuroscience is the need for the brain to be emotionally safe for cognition to occur. This knowledge informs both the nature of the optimum learning environment and the quality and nature of classroom interactions and teacher–student relationships. The less stress and anxiety that student experience, the more able their brain is to learn, so being positive is important. Positive learning environments can support the interaction of the five learning systems so they are mutually productive.
- Teaching and learning in early years numeracy is an essential aspect of beginning successful mathematical thinking.
- Students from low socio-economic backgrounds may have numeracy difficulties that are compounded by their language capabilities.
- There are cultural differences in ways in which diverse parts of the brain are activated during mathematical and numeracy tasks.
- The entire body is involved in learning. Physical health and activity is significant in the learning process as are the ample, appropriate provision of opportunities for sensory experiences.
- Students who are not well nourished, are sleep deprived or afraid, distressed, anxious or otherwise unhappy are unlikely to be able to learn as effectively as those who have nutritious diets, adequate sleep and feel safe in the learning environment. It is difficult for them to fulfil their full learning potential, even if they are otherwise motivated to learn.
- Creativity is important for effective learning as it coordinates parts of the brain not utilised together in more ordered, convergent thinking. It facilitates the investigation of problems and generates new plans and designs for solving these problems by engaging students in divergent thinking.
- Mathematics homework may easily be counterproductive or act as a deterrent to the development of mathematical skills and numeracy competencies.
- *For example, engaging in any of the activities which involve students creating their own versions, notions or models of activities would be useful. Tasks such as the ones detailed in the Health lessons support the understanding of healthy lifestyles for optimal learning. The Year 5/6 Dental Health lesson investigates alternative methods of maintaining oral hygiene, (which some students may regard as a boring twice daily chore). The tasks have a creative component as students may make variations to their teeth cleaner recipe and, irrespective of the taste, none of the resultant cleaners are incorrect—the mathematical challenge may be to alter the proportions of the recipes to make the products more palatable!*

Atypical Brain Wiring and Its Impact on Numeracy Development

Although learning problems in developing numeracy competencies are estimated to be more frequently (Ansari & Karmiloff-Smith, 2002) than problems in literacy, numeracy problems have not attracted as much research or educator attention as those related to literacy. Students with otherwise normal development patterns who exhibit substantial, ongoing problems with arithmetic are said to be suffering from numeracy deficiency or dyscalculia (Ansari & Karmiloff-Smith, 2002). (Berninger & Richards, 2002; Cohen Kadosh, Dowker, Heine, Kaufmann, & Kucian, 2013; Landerl, Bevan, & Butterworth, 2004). Dyscalculia can be developmental or acquired. Developmental dyscalculia is not associated with head trauma, acquired dyscalculia is the result of this trauma (Munro, 2003). This deficiency is not believed to be result of other deficiencies, such as dyslexia (Bevan, Butterworth & Landerl, 2004) although they are frequently found together and there is a strong relationship between numeracy and literacy development in the early years (Kleemans, Segers, & Verhoeven, 2011; Neumann, Hood, Ford, & Neumann, 2013; Purpura, Hume, Sims, & Lonigan, 2011). Research indicates that students who suffer from both dyscalculia and dyslexia have significant differences compared to students who suffer from dyscalculia alone (Ansari & Karmiloff-Smith, 2002) and that these two disorders are often accompanied by Attention Deficit Disorder, which adds further complexity to the strategies used to support students with dyscalculia as they cannot be considered to be a homogenous group. It appears that students who suffer from developmental dyscalculia may often be suffering from a number of other learning disadvantages (Landerl, Gobel, & Moll, 2013).

Ansari and Karmiloff-Smith (2002: 511) describe numeracy as a 'particularly vulnerable cognitive domain in the atypically developing brain' and note it is particularly prevalent in genetic disorders and children born preterm, despite other areas of learning and scales of intelligence being scored highly. It has been found that children born preterm had less grey matter in a specific section of their left parietal lobe than children who do not have numeracy difficulties. The focus of the rather frugal amount of research on dyscalculia has appeared to focus predominantly on number specific actions like number operations, However, where research is has been focussed on the impact of dyscalculia in less specific learning domains, it had been found that students (i) have immature problem-solving strategies (Harris & Ford, 1991) (ii) have poor working memory span leading to computational errors (Harris & Ford 1991) (iii) deficits in long-term retrieval of arithmetic number facts (iv) slow processing speeds (v) disturbances of visual-spatial functioning (Ansari & Karmiloff-Smith, 2002: 514) which impact on all domains including numeracy.

What does this mean for you as a teacher of numeracy?

- Dyscalculia is at least as prevalent as dyslexia. Some children may have both difficulties; some may also have Attention Deficit Disorder and others may have multiple learning difficulties. However, premature decisions regarding the identification of students with dyscalculia is not only unhelpful for the students, but outside the expertise of most teachers, so professional support would be required for the diagnosis and strategic support of students suffering from dyscalculia in much the same way as it is for students with dyslexia.
- Incidences of dyscalculia are prevalent in **some** genetic disorders and amongst students who have been born preterm.
- There are two types of dyscalculia, one is developmental and the other is acquired.
- Dyscalculia is not confined to numerical calculations but to other skills that are important for learning across the curriculum.
- The working memory and other cognitive capacities of executive function skills are important aspects of learning in numeracy so even very young children can benefit from activities designed to strengthen working memory skills and other executive function skills, especially in the parietal lobe.
- Dyscalculia impacts across all learning as it impacts on all the diverse aspects of numeracy, not just numbers and calculations.
- *For Example, to support students with any of the learning characteristics mentioned above, activities which are ongoing, which have a concrete component, are non-competitive and which do not rely heavily on speed of completion and oral instruction would be useful to the learner. The English lesson for Foundation students, Animal Alliteration, for example, allows students to participate with lots of repetition, is not fast moving, has several reminder clues and cues and is a group activity. Instructions are simple and are repeated each step of the way so that students can feel confident. Variations to this task can be group or activity based to allow specific students more support or more time to complete a list of what they see in diverse, familiar contexts. This can be further supported by providing the visual representations of what the students may see in the context being discussed. The dots on the dice facilitate the development of 'counting on' and doubling strategies which involve both additive and multiplicative thinking and can be easily made more complex by making and using home-made dice with bigger numbers for older students.*

Conclusion

This chapter investigated the workings of the brain that are currently known in relation to the development of numeracy and mathematical learning. It also introduces the idea of 'neuroeducation' as an essential component of studying how best to facilitate learning. Learning depends on the brain's capacity to integrate and orchestrate activity in many parts of the brain to perform even simple tasks in numeracy. The two hemispheres of the brain are constantly and instantly in communication with each other via the nerve clusters of the corpus callosum and the anterior commissure but the exact organisation and brain activation of many areas of mathematical skills and capabilities and numeracy competencies cannot be identified at this stage, despite their undoubted importance to educators in general and teachers in particular. The area of the brain identified as the parietal lobe has been recognised, however, as being of particular significance in the development of mathematical skills and numeracy competencies. An important consideration, however, may be the confirmation of the significant impact that emotions have on learning; confirmation of the knowledge that the brain cannot function effectively or efficiently unless it 'feels safe' (Medina, 2010; Sousa, 2010). Negative feelings and contexts will not facilitate optimum, learning in numeracy or mathematics, either in school or at home. Other circumstances, such as the low socio-economic backgrounds of students and cultural diversity and the subsequent impact on the students' brain development in innate and developed skills in quantity have been indicated. The importance of early numeracy skills have been highlighted by Limpina and Posner (2012) including the essential nature of students' capacities in the concept of one to one correspondence. Additionally, the notion of dyscalculia, the incidence of dyscalculia and dyslexia, both together and with additional disadvantages in the brain; and the subsequent impact on the successful acquisition of mathematical concepts and numeracy skills applied across the diverse areas of learning in classrooms, had been introduced.

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Improving the Learning Experience

Maura Sellars

Introduction

The critical factor in the very human interaction that occurs in classrooms in the teaching and learning context is pedagogy. What is done, how it is done and by whom has an enormous impact on the capacity of students to learn. Teaching is a moral, value-laden activity within which there is a considerably disproportionate balance of power (Campbell, 2007). Whilst teachers' work is complex and challenging, it must also be professionally evolving and sensitive the learning needs of the students. There are justice issues embedded in every comment, gesture, decision and response made to every student (Newman & Pollnitz, 2002). Teaching in itself is an act of trust between the teacher, the general community, the parent body and the students themselves (Thompson, inCampbell, 2007: 104). Currently, professional teacher culture is being reshaped in the light of increasing diversity in classrooms, the increasing rate of change, the educational role played by authentically integrated technological materials, the increasing demands of education in the twenty first century and the overall impact of globalisation (Angus, 2007). The traditional roles of teachers as the unchallenged providers of all knowledge have given way to a wider understanding of teachers as facilitators and mentors of student learning in all but the most conservative or most traditional parts of the education system. As the roles of teachers change, so must the reciprocal roles of the students. In all but the most authoritarian classrooms, students are increasingly able to develop their own strategies, knowledge and concepts in collaboration with their teachers and peers. This not only gives the learners more responsibility for their own learning but also alters the nature of the teacher–student interactions, so they become less transmissive and increasingly transactional and transformative (Wink, 2011).

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The pedagogies with which teachers engage in their interactions with their students actually reflect how they personally perceive the role of the teacher. In many circumstances, teacher beliefs and values about effective teaching are influenced considerably by their own schooling, despite the absence of many of the characteristics and challenges that are faced by teachers in today's classroom contexts. Many believe that transmission pedagogies are the most appropriate strategies to support teaching and learning, despite these differences and despite the fact that though they themselves were at least reasonably successful in these contexts, many of their peers were not (Malm, 2009). Campbell's (2007) observation regarding the disproportional balance of power in educational contexts is also reflected in teachers' selected pedagogies. Teachers who do not critically reflect on the exclusive nature of syllabi, standardised testing and traditional pedagogies to maintain one worldview or perspective are actually discriminating against all the students in their classes who do not have the requisite capital to take full advantage of an education predominated by these terms and values (Bourdieu, 1986, 1990). These teachers use their teacher power and pedagogical strategies to maintain the status quo, not to offer an education that empowers all. Despite the demands of the current 'age of compliance' (Groundwater-Smith & Mockler, 2009), teachers who wish to respect diversity, plan for inclusive classrooms and authentically engage with issues justice for all their students must find pedagogies that use their teacher power to empower their students as learners (Gutstein & Peterson, 2005; Harrell-Levy & Kerpelman, 2010; Hyde, Carpenter, & Conway, 2011). This is particularly important in numeracy, as it is reflected as students' social practice and indicates the multiplicity of experiences and backgrounds that students bring to school as 'capital'. That is not to say that students from backgrounds other than the majority culture should not have access to the 'powerful knowledge' (Young, 2008a, 2008b; Young & Muller, 2014) of disciplinary structures and metalanguage. It means that part of the complexity and challenge of teaching in the twenty first century is to build on the various experiences that students have already learned from in their own contexts, to start new learning and conceptual development in ways that make meaning for all students and to gradually ensure access to powerfully disciplinary knowledge in ways that support different learning preferences, diverse perspectives and social justice. In order to attempt this complex professional undertaking, appropriate pedagogical strategies must be examined, evaluated and implemented.

Pedagogies that Empower

Empowering students to construct their own knowledge and understandings requires teachers to behave in certain ways and develop specific types of relationship with their students. In reality, these pedagogies change the role of the teacher and the role of the students and have the potential to bring a balance of power into teachers' professional relationships with their students (Sellars, 2008a,

2009) and establish respect and acceptance of student diversity (Gardner, 2006a, b, 2011). A number of models of teaching are discussed, many of which may challenge perceptions of traditional teacher roles and roles of students, including the notion of the locus of control that teachers have traditionally been understood to automatically earn and enjoy as part of their work in classrooms. Additionally they all stress the importance of peer and student–teacher dialogue (Splitter, 2009). Miller and Seller (1990) developed a model of three major educational strategies, each of which have different characteristics in each of these dimensions: (i) control and sharing of power (Harris & Ford, 1991), (ii) what counts as legitimate knowledge (Harris & Ford, 1991), (iii) how meaning should be constructed (iv) the intended learning outcome and (v) the pedagogical approach (see also McGregor, 2008: 52–53). These different approaches were used by Cummins (2009) to develop a conical, embedded model of an appropriate pedagogical approach for teaching English as an additional language. The model illustrates a tiny percentage of transmission pedagogies embedded in a substantial proportion of transactional pedagogies completely enclosed in a much larger context of transformative pedagogies (see also Wink, 2011: 189). In this model, each of these approaches to teaching and learning has its place in extending and supporting student learning. One pedagogical approach, namely transmission pedagogies, when implemented as a dominant or exclusive approach, does little to empower students. In fact, over a period of time it can result in students not only being disempowered in their learning, but also becoming increasingly indiscriminate in their learning, failing to think deeply, to critically reflect, to solve problems and to make meaning of the knowledge, skills and strategies they have learned by rote. As a result, they fail to engage with the twenty-first-century skills of critical and creative thinking, collaboration and communication. Transmission implies that the knowledge is provided by the teacher with the expectation that the students learn this knowledge competently enough to repeat it when prompted. Direct instruction is different strategy, frequently used to 'formalise' knowledge in ways in which it can be readily understood by others and is usually engaged with when students have competently grasped the knowledge which is being presented.

One pedagogical model that does support students' own construction of knowledge originated in the basic foundations of Constructivist theory (Hacker, Dunlosky, & Graesser, 1998; Hein, 1991). All constructivists propose that individual learners must actively construct knowledge (at times not without a struggle) in a personally meaningful way, and they must be able to attribute meaning to their learning whilst engaging in dynamic personal and social processes. This is an important pedagogical model for educators seeking to promote numeracy competencies. Based on the work of Piaget (Gruber & Voneche, 1977), Dewey (1933, 1958, 1966a, 1966b), Vygotsky and others, (Hacker et al., 1998; Prawat, 1999) this view of learning impacts on both the learning theory and epistemology, which is the branch of philosophy which studies the actual nature of knowledge itself, in that the nature of knowledge is personally mediated (Hein, 1991). Exploration of the similarities and differences in Piaget's and Vygotsky's visions of constructivism as understood by Askew and Bruner can be found in Sellars (2013: 95–96).

Howe and Berv (2000: 30–31) support the Deweyan notion of constructive epistemology. They comment that Deweyan pedagogy starts with what students know, value and are interested in, and progresses from there. Dewey himself acknowledged this pedagogical practice to be a more difficult teaching approach than the more traditional practice of teaching by transmission. However, it avoids the criticisms of other constructive models. In Deweyan pedagogy, when successful, students complete their learning opportunities with shared meanings particular to their community as the result of exploration, deep thinking and reflection; all of which are completed in the context of shared dialogue (Splitter, 2009). This avoids a particular criticism of constructivism, what Howe and Berv (2000) describe as leaving 'knowledge ultimately stranded on private constructions' (38). In their discussion of pedagogical models in education, Howe and Berv (2000) propose that constructivist learning theories have two foundational principles:

- Learning takes as its starting point the knowledge, attitudes and interests students bring to the learning situation.
- Learning results from the interaction between these characteristics and experience in such a way that the learners construct their own understanding from their subjective understandings.

As a result, constructivist pedagogy has two 'parallel' foundational ideas

- Instruction must take as its starting point the knowledge, attitudes and interests students bring to the learning situation.
- Instruction must be designed so as to provide experiences that effectively interact with these characteristics of students so that they may construct their own understanding.

One important aspect of the Constructivist perspective is that it is open ended and without boundaries. In this respect, it mirrors what is actually known about the neural structure of the brain, as this is also open ended (Posner, 2005). In addition to supporting Splitter's (2009) notion of authentic education, which honours the inner, subjective self as an active learner in the educational process in the manner proposed by Dewey (1933), it emphasises the importance of successful learning and what is now known about the brain's responses to successful learning (Willis, 2010). While there are a number of neurochemicals that and hormones that impact on learning, the chemical dopamine increases its levels in the brain when successful learning is achieved and not only makes the experiences more enjoyable for the students, but also increases memory, focus and motivation (Storm & Tecott cited in Willis, 2010: 55).

Planning for success in tasks involving numeracy competencies has the potential to mitigate some of the negativity (Lange & Meaney, 2011) that is frequently found in relation to teaching and learning in mathematics and numeracy. Interestingly, amongst the strategies that Willis (2010: 60) suggests to improve the brain's natural propensity for seeking out patterns are (i) making analogies and seeking out similarities and differences (Harris & Ford, 1991), (ii) using pre-unit assessment that students can self-correct and submit for non-grading feedback (Harris & Ford, 1991), (iii) using current events of high interest for group discussion (Sullivan), (iv) using ball toss activities, (v) explicitly making links in cross curricular subject domains, (vi) using age-appropriate activities during which students can investigate and identify the pattern that the teacher is using, (vii) using non-linguistic strategies like graphic organisers that help students organise their ideas (Dixon-Krauss, 1996) and (viii) using multisensory learning so multiple impressions of the information are stored in various areas of the brain and more areas of the brain are stimulated.

What does this mean for you as a teacher of numeracy?

- Dialogue is important to learners' construction of their own knowledge and to the validation and verification of this knowledge as common or correct understanding
- Multisensory activities and whole-body learning are imperative for diverse parts of the brain to be stimulated and to store information in multiple regions
- Making linkages, or learning numeracy through other areas of the curriculum, is important
- Planning for success can have a substantial impact on the students' attitudes, motivation and enjoyment
- The brain is programmed to seek and recognise patterns. A variety of activities that support the development of pattern seeking and identification can scaffold learning in mathematics and numeracy, irrespective of specific discipline contexts
- Learning starts with what students already know, and learning tasks must be designed to build effectively on these understandings
- Transmission pedagogies can be overused and result in passive, non-discriminatory learners who lack twenty-first-century thinking skills and capacities
- A large part of the challenge of teaching in current learning contexts is working within the students' social and cultural understandings and relating these to the more formal characteristics of discipline-based knowledge
- Pedagogy matters. The ways in which students are taught defines the ways in which they are encouraged to interact in a learning context, to think deeply and to become independent learners
- Productive pedagogies are multidimensional.
- Depending on the task, context, the stage of student learning and the individual student themselves, direct instruction, students' own exploration and transmission pedagogies may be incorporated into the teaching and learning context. The important question may be 'Have students had sufficient opportunities to explore the conceptual foundations of the learning and are they ready to formalise this knowledge?' if students are

not all ready at the same time, (as is so frequently the case), explicit teaching can be with small groups who are ready to move on and competent teachers often transmit helpful ideas to learners.

- *For Example, the Drama lesson for Foundation students is initially teacher directed using explicit instruction. It is based on a familiar context and introduces students to the notion of using counting for dramatic effect and then movement that represents the motion in the context they are working in as a drama experience. The explicit instruction creases as the students become confident and familiar with the technique and the students then use improvisation to express their own understanding of the dramatic context. Many of the students would not need to direct instruction to commence follow up lessons and may start with exploring their own choice of context, using counting forward and backwards and a range of improvised movement to express themselves in terms of spatial concepts, duration and elapsed time. Many of the Dance lessons also use this direct introduction to strategy or technique as a starting point for new learning.*

Transformative Pedagogies

Other models of pedagogy that are particularly relevant in the current learning context are those that are identified as transformative pedagogies. These are developed from the works of Freire (1970) and expanded predominantly in the area of adult education (Boyd & Myers, 1988; Cooper & Boyd, 2002; McGregor, 2008; Mezirow, 1991, 1998; O'Sullivan, 1999). Implicit in these models of pedagogy is the notion of developing students' critical thinking skills to transform various aspects of the teaching and learning contexts, learning themselves in their cultural and social settings. These include redefining the learners as active, critical thinkers whose role is to develop social awareness and work towards a more socially just world (Kincheloe, 1999). Defining this process as an exclusively adult education strategy has shifted somewhat, with an emphasis on acceptance, multiple perspectives and social justice issues increasingly being discussed in terms of education for younger students (Burgh, Field, & Freakley, 2005) with the introduction of 'communities of learners' into primary school contexts. Kalantzis and Cope (1986) examine this notion in terms of multiliteracies, which are the examination of the ways in which language is used in different cultural and social contexts and the impact of this on learning (Cope & Kalantzis, 2009; Kalantzis & Cope, 1986). Other sources seek to explain the importance of transformative strategies as student-centred learning ('Transformative Pedagogy: Concepts,') that encourages students to critically examine their own beliefs and assumptions and to increasingly value multiple perspectives.

These pedagogies require the purpose of education to be understood as a means of achieving social justice, and not perpetuating what Freire (1970) has famously dubbed 'the banking model' of education. Instead of passively accommodating the information and perspectives of teachers, students learn through engaging with experiences and issues that necessitate both action and contemplation. These include various aspects of critical pedagogy (Freire, 1970; Stevens, 2010), including the notion of praxis, which is historically based on the writing of Aristotle (Nisbett, 2005), in which he separated knowledge into theoretical, productive or practical, depending on its moral purpose. Praxis today is currently understood to be a spiralling integration of, and dialogue between, theory and practice, and is frequently associated with critical pedagogy. It is understood to be a creative undertaking in which there is no 'right' way to achieve a particular end; learning is a constant interpolation of interpreting, understanding and applying. It also includes experiential learning.

Experiential learning is frequently the focus of much criticism (Breunig, 2005) because it is perceived to be lacking theoretical foundations in much the same manner as highly theoretical models of pedagogy, such as critical pedagogies, are criticised for not indicating the types of teaching and strategies that are required (Gore, 1993). This can be extremely problematic, but much of the difficulty surrounding the implementation of new pedagogical practices occurs at the systems level (Cummins, 2009). The ways in which teaching occurs, the relationships that developing in learning contexts and the ways in which national and other systemic testing programmes are allowed to influence not only what is taught, but how it is taught, are largely determined by the school systems and those who develop systemic priorities and policies, rarely by those who actually teach in classrooms with real children. In these instances, 'pedagogies act as regimes of truth' (Levitt, 2008: 51) and challengers to these are dismissed or disadvantaged. There is a need for school leadership, especially pedagogical leadership, school organisation and structures to be redeveloped in order to facilitate change and innovation in teaching (Dimmock & Goh, 2011) because educational directions and actions at the systemic level serve to reflect the very purpose of education. As such, it reveals that all pedagogies are political.

Currently a rather dismal, uncreative purpose is revealed, one in which the creativity and innovation that students will need for living in this century is barely supported (Sellars, 2013). One very notable exception is the introduction of culturally appropriate, creative pedagogical strategies to support the learning of Aboriginal students ('8 Aboriginal ways of learning,'), which, if implemented sensitively, could go some way to making the learning for these students initially more meaningful. However, much additional work needs to be done to transition these learning strategies into approaches that give these students equitable access to powerful knowledge in a systematic manner. Included in this reconceptualization of the ways in which schools need to operate in the current climate is the acknowledgement that teachers have a significant role to play in the development of leaner identity (Darling-Hammond, 2009; Harrell-Levy & Kerpelman, 2010), in this case, the development of learners as numerate individuals (Macmillan, 2009). It is apparent from the previous discussions that traditional, transmission-type teaching cannot be successful for groups of students with different ranges of learning difficulties and disadvantages. However, it may also not be relevant to several other students simply because the social relationships between the teacher and the learners that are maintained by this method of teaching do not support or allow for students' differences or diversity. This approach 'standardises' students and presents only the system's and the teacher's understandings and views of the world, neglecting cultural, social and individual student differences. As the notion of numeracy (in addition to other curriculum areas that are heavily invested with social and cultural practices) a newer pedagogy needs to be explored in order develop students with numerate identities.

Breunig (2005) explored the implementation of a blended programme based on critical pedagogies and experiential learning. She took the characteristics of critical pedagogy, examining how content and knowledge are taught; examined the values and beliefs that underpinned what this content and knowledge comprised; and investigated how students authentically engaged in the learning process. To this she provided the hallmarks of experiential leaning—the opportunities to be engaged first hand in learning experiences with the teacher or mentor and possibilities to be engaged with them in focussed contemplation and reflection. It is widely accepted that theory can inform practice and that practice provides opportunities to better interpret and understand theory, but frequently the gap between theory and practice is remains substantial. Breunig suggests that engaging students in activities that help them identify whose values are being embraced in pedagogical models and whose interest are being served in curriculum choices helps to mediate the theory/practice mismatches in the theory and practice interpolation that is praxis. Engaging students in critical reflection of the underlying beliefs, values and assumptions of what they are learning; the strategies utilised in the selected pedagogical interactions; the examination of their own roles in the learning process; and the ways they individually learn best bears many of the trademarks of transformative pedagogies.

As mentioned previously, transformative pedagogies in the context of younger students in classrooms are teaching practices that aim to empower students to reconceptualise their understandings of 'self' as learners. They are aimed at placing the student at the centre of the learning, giving them a voice and empowering them to make decisions about their own learning. In this way, they fulfil their purpose of regarding education as a means to achieve social justice. Transformative pedagogies acknowledge that there are many ways of knowing and that all of these have value, inform each other and need to be respected. The overarching philosophy that transformative pedagogies bring to the classroom is that all learners have power to change the status quo and actively promote social change for themselves, and eventually, for the betterment of wider society. In order to do this, students have to be the focus of the learning and be mentored by teachers who understand and value the wisdoms and knowledge students bring to the learning context

(Biesta c& Miedema, 2002). Students then are empowered to build their own identities as learners, and are able to transfer their learning into contexts outside the classroom with the intention of impacting positive social change in their immediate context and then into a wider community. Characteristics of transformative pedagogies include

- The role of the teacher as the informed adult who mentors and supports learning in much the same way as Vygotsky discussed when explaining the role of the teacher when supporting student development further within the boundaries of their individual 'Zone of Proximal Development' (ZPD) (Dixon-Krauss, 1996; Gordon, 1995; Prawat, 1999).
- The teacher values and multiple representations of knowledge by respecting constructivist epistemologies. Students need to create knowledge and acknowledge that it is socially constructed.
- Students are provided with opportunities for discussion, debate and dialogue. They need to engage with probing questions, question their own assumptions and develop a high degree of self-knowledge.
- Teacher and students engage in reflection and a variety of tasks that promote contemplation individually and with colleagues and peers (Sockman & Sharma, 2008).

This pedagogical framework appears to be ideally suited to the challenge of how to create teaching and learning contexts that facilitate optimum learning opportunities for students to develop the skills embedded in *The Personal Model of Numeracy* (Fig. 1.1). While the notion of transformative pedagogy has been well explored in the contexts of adult education (e.g. Dyson, 2004; Pilling-Cormick, 1997) and is slowly making its way into school classrooms (Burgh, Field, & Freakley, 2006; Kampol, 1998; Levitt, 2008), it will take considerable changes in the pedagogical practices of some teachers if this model is to be embraced in their classrooms. This is most especially as these two approaches (transmission and transformative) are politically, pedagogically, philosophically and educationally opposing paradigms of working in educational context. Sockman and Sharma (2008) provide some suggestions for teachers who wish to engage with transformative pedagogies. These are suggestions for reflection

- It is easier to tell than to listen
- Modelling needs to go beyond a monologue
- Be humble and learn from the students
- There are more ways to the same end
- Grading the end product or acknowledging the risk?

What does this mean for you as a teacher of numeracy?

- The prior leaning that children bring to their classroom experiences is valuable and empowering for students when it is recognised and respected by other students and by teachers
- One of basic tenets of Social Constructivism (Dixon-Krauss, 1996), that of the informed mentor scaffolding and supporting student learning *as they need it* is honoured in this pedagogical model
- The learning experiences and tasks are, of necessity, learner focussed and should be designed to challenge students' thinking, assumptions, attitudes and preconceptions
- Reflection and dialogue are fertile opportunities for challenging, debating and confirming notions of self and must be allocated some degree of priority in timetabling and planning in order to be authentic
- Collaboration with others and acceptance of difference and diversity are cornerstones to the foundational purposes of transformative pedagogies; the capacities to appreciate different perspectives, recognise that knowledge is socially constructed and that personal assumptions and beliefs should be questioned in an effort to promote a more equitable society
- Social transformation is the key purpose of transformative pedagogies as discussions and learning tasks are developed to raise student awareness of social injustice, inequity and discrimination. Many of these numeracy tasks can be developed using the guidelines presented in the Four Resource Model of Critical Numeracy (Watson, 2009) which forms part of the Personal Numeracy Model (Fig. 1.1).

Tasks that Matter

The pedagogical approach that teachers take in their classrooms also dominates the types of tasks that students are provided with as learning activities. Transactional and transformative pedagogies demand tasks within which students can have some opportunities for personal responses, explanations and strategies and then share, compare and consider these in the context of the responses to similar tasks undertaken by their peers. Rich tasks are often developed by teachers who engage substantially with these pedagogical approaches. Rich tasks are frequently open-ended tasks, which, in addition to having no 'right' answer, are at least contextualised, require student investigation, exploration and problem solving and demand rich learning environments. One other defining characteristic is that the tasks must be accessible to all students, irrespective of their numeracy competencies. Rich tasks in numeracy are frequency investigations, explorations or project based tasks fulfil set criteria. There are several lessons in Section Two that can be recognised as rich tasks. Rich tasks many also require students to pose and answer their own questions, use different methods of inquiry and present learning in different representations. There are innumerable resources that suggest rich tasks in mathematics and numeracy are available electronically for use by teachers in schools. Many of these rich tasks are also authentic tasks in that they 'mirror' real-life situations that require higher order thinking, investigation and the students' own strategies for problem solving, recording and representation. Again, there are abundant resources available online. Perhaps an obvious inclusion is student-directed tasks. These learning opportunities provide students with additional choices. Very often this is provided in the selection of the content, focus, demonstration of learning, product or representation. Students who engage with these tasks most successfully are those with high levels of self-knowledge and highly developed cognitive capacities, collectively known as executive function skills (Bernstein & Waber, 2007; Meltzer, Pollica, & Barzillai, 2007; Moran & Gardner, 2007; Sellars, 2006, 2008a, 2008b, 2009).

What does this mean for you as a teacher of numeracy?

- Learning tasks reflect pedagogy, which in turn reflects what teachers believe and value about their professional activities
- Higher order thinking skills, evaluation, criteria and strategies for exploring and enquiring are critical for life-long learning in the twenty-first century
- Open-ended tasks, rich tasks and authentic tasks may all be utilised in the context of transactional and transformative pedagogies
- Students often need support to develop sufficient self-knowledge and the cognitive capacities of executive function
- The capacities of executive function can be taught, developed and strengthened by the types of learning tasks in which teachers ask their students to engage
- It is frequently counterproductive to expect self-directed learning tasks to be completed successfully by students whose educational experiences in classrooms have been almost exclusively transmissive
- Direct teaching pedagogies are often useful in teaching a basic skills procedure or idea from which students can launch their rich, authentic and self-directed tasks. They are not as useful when they are used as a dominant pedagogy, as a staple diet and to present a single perspective of knowledge, strategies, and conceptual understanding.
- *For Example, the Geography lesson for Year One students incorporates self-regulated learning with the simple framework and resourcing of the lesson. The students are involved in discussion, decision making and recording in small groups. They are determining not only the question of natural or man-made, but are also reflecting and deciding on comparative distance, location and justifying their estimations by measuring with*

informal measures. They can revisit the visual representation of one aspect of the lesson to facilitate further reflection and discussion. In comparison, the Science lesson for Year Two is completely based on direct instruction. This is because the paper making process is quite precise and individual variations to the process may be very interesting and provide a unique result, but the product most likely would not be paper! An example of a rich task that allows students to participate at their own competency levels can be found in the Year Five lesson in Media; Create a How to do it Video: Making a weaving symbol project. Students can engage in this task with basic and sophisticated numeracy competencies embed into the various components of the task.

Creativity

As indicated previously, current curriculum pressures and the demands for student achievement on standardised, externally determined testing regimes has resulted in the arts in particular becoming the subject of much implicit derision and explicit neglect in schools. There are a number of reasons why this is not only short sighted but counterproductive to the aims of the Melbourne Declaration (Ministerial Council on Education Employment Training and Youth Affairs, 2008). This perspective of educational priorities not only denies students the enjoyment of participating in subjects such as classroom music, drama, dance and visual arts, but it also completely ignores the findings of neuroscience about the creativity of the learning brain (Sousa, 2010), the research around social and emotional aspects of learning (Immordino-Yang & Feath, 2010) and the total dependence of Australia's future on citizens developing competent skills in creativity and innovation (Ministerial Council on Education Employment Training and Youth Affairs, 2008). There is really a considerable mismatch between the reality of the current knowledge-based, information-driven era and many of the pedagogical practices that are in use today in all areas of the curriculum and that served the factory-driven institutions of the last century.

The brain is wired to be creative. Research has found that students who are engaged in divergent thinking tasks have greater activity across multiple regions of the brain, most specifically in areas of the brain structures that facilitate cognition, emotion, working memory and novelty response (Hardiman, 2010). Researchers of behavioural and cognitive sciences have found that tasks that involve creativity are beneficial for all students as they learn and develop the 'studio habits of mind' which include, amongst others, 'stretch and explore' and reflect (President and Fellows of Harvard College, 2010). Embedded in the studio habits are capacities that are applicable across the curriculum areas, including persistence in completing tasks over time, making connections between school learning and learning outside of the formal educational context, self-expression and acknowledging the value of their own voices and thinking, innovating through engagement with the nature and man-made environments and proficient, self-evaluative strategies for self-critique, assessment and reworking their own products.

Traditionally, creativity has been thought of as a trait which individuals somehow possess innately or not. However, creativity can be taught. Hardiman (2010: 235–236) has developed *The Brain Targeted Teaching Model*, which has been proven to help students develop deeper understanding and application of their knowledge by infusion of the arts across the curriculum as particularly pleasurable learning activities. The six aspects of this model were designed to create activity in various parts of the brain, resulting in stronger neural networks created by the brain working simultaneously in the diverse areas that would ordinarily never work in tandem if students were not engaged in divergent tasks. Tasks that do not require imagination and creativity (convergent tasks) also do not require these extraordinary neural combinations that have the capacity to enrich and enhance a range of cognitive capacities as thinking skills.

One aspect of brain functioning that was revealed as being of primary importance to the learning process was positive emotion, a characteristic explored by a number of educational theorists (Fredrickson, 2000, 2001; Noble & Mc Grath, 2008; Seligman, 2002; Seligman, Ernst, Gillham, Reivich, & Linkins, 2009). Stress and anxiety were observed once again to have a negative effect in the brain's capacity to learn effectively. While all these findings are positive indicators of the importance of the arts, these curriculum areas have to explicitly taught, as do other subject domains, so the students have the knowledge, skills and concepts with which to develop their creative activities and their innovative thinking. The integrity of the subject domain always needs to be retained, both in the arts and in other key learning areas. While activities, integration and different embedded pathways are always useful for the teaching of mathematics (for example Fox & Surtees, 2010), observation of and discussion with students whilst they are working in areas that utilise their most effective neural pathways and which are interesting, stress free and creative can easily provide an alternative avenue for students to use their acquired numeracy skills to inform their learning in the disciplinary representation and procedures of mathematics learning.

What does this mean for teachers of numeracy?

- Creativity can be taught. It is not completely genetic.
- The brain is made to be creative.
- Engaging in creative activities has many benefits for students. These benefits can permeate all aspects of school life.
- Emotional safety is an extremely important aspect of learning.

- The brain activates differently and in more regions when students are employing their energies in creative tasks or are required to develop innovation plans, solutions or designs.
- These types of divergent thinking skills contribute positively to students' concentration, working memory, thinking skills and emotional security (some of which are amongst the cognitive capacities of executive function).
- Tasks that require only convergent thinking skills do not activate as many regions of the brain, allow different regions of the brain to access each other or provide opportunities to build strong neural learning pathways, as tasks requiring divergent thinking do.
- Skills and concepts need to be taught in diverse ways, using multiple pedagogical strategies, so that the capacities being investigated can be developed and understood by all learners in ways that facilitate student' using them in diverse, innovative or creative ways.
- *For Example, there are many lessons in Section Two that are creative and use mathematical knowledge innovatively and can be implemented to engage and motivate students. The Music Lesson for Year Two students is a good example of using graphic notation and the PE lesson for Years One and Two have the same inclusive nature in that the activities are clear; irrespective of language restrictions. These lessons are also easily modified for students with physical difficulties.*

Conclusion

This chapter has focussed on the importance of pedagogy. It has discussed three major pedagogical perspectives and explored how constructive and transformative pedagogies could be implemented within school contexts and circumstances and have the potential to promote social equity and change, change which requires students to be increasingly critical in relation to the qualitative information that pervades society today. Transformative pedagogies also have the potential to connect students with who they are in a cultural and social sense and to empower them as learners. These pedagogical strategies provide opportunities for students to learn by engaging in personally meaningful ways, with an ultimate goal of empowering them as learners in their immediate circumstances and beyond. Teachers' selection of learning tasks, teacher–student relationships and students' relationship with their peers are all shown to be determined by the pedagogical approaches teachers implement in classrooms. The value of creativity and innovation has been established and its potential to impact positively on students' learning brains and their academic successes has been explored. It is proposed, at this point, that, in order to ensure that all today's students are adequately prepared for tomorrow's global citizenship (Steen, 2001), the numeracy competencies that individuals bring to or develop in the context of other areas of learning may be an alternative pathway for many students to learn more successfully in the formal requirements of the discipline of mathematics. In doing this, many of the perceived barriers to learning in mathematics may be overcome or at least mitigated by the students' engagement in, and enjoyment of, learning in other content areas, which, as presented in the next section, retain their disciplinary integrity and are not presented as mathematics in disguise.

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Aboriginal and Torres Strait Islander Students as Effective Numeracy Learners

Jon Austin

I'm driving along the coastal edge of the Daintree Rainforest in far north Queensland in a four-wheel-drive vehicle (necessary for Western and convenient for indigenous travel in this part of the world).[1] I'm on the road between Shipton's Flat and Wujal Wujal, some 60 km to the south, talking with Errol and Peter about this most magnificent part of Queensland. In the front seat of the car is a university colleague, Ben.[2] Both Ben and I are non-indigenous Australians. At this point, the road parallels the Bloomfield River for some time, and we reluctantly pass up an opportunity to take the turn off the highway to visit the politically infamous Cedar Bay. Peter and his wife, Marilyn, are the registered traditional owners of this country, the land of the Bana yarralji people. Errol is a direct nephew of Peter and Marilyn, and is a next-generation "elder-in-training" (my term, hopefully used without any offense being caused).

As we pass certain landmarks—typically unnoticed by either of us whites—one or other of our passengers would cut across the conversations to tell us of the cultural significance of these points on the terrain. The conversations, including the storytelling tangents, were replete with instances of mathematics or numeracy in practice, although, from a Western perspective perhaps not quite so obviously.

Errol: Once we went up in there looking for magpie geese
Ben: What did you want the magpie geese for?
Errol: We had a big gathering
Ben: How many people?
Errol: Everyone, everyone came

[1]The extract introducing this chapter is an anecdotal reconstruction of a conversation engaged in as a part of a larger funded project. All permissions for use, including in reports and associated publications, have been covered by the terms of that project.
[2]A pseudonym.

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Ben: So, how big are these magpie geese? How many did you need?
Errol: [long pause] Enough for everyone
Ben: How many was that?
Errol: We caught some and if there's any left over people took them.

The "Ineducability" of Aboriginal and Torres Strait Islander Students

This is not a chapter about how to better teach Aboriginal and Torres Strait Islander students relevant curriculum knowledge in the area of numeracy or mathematics. My intention is to expose the extreme complexity of the bicultural (at the very least) educational contexts within which many such students attempt to become literate, the success of their efforts, unfortunately, being measured only from one of those contexts. My purpose here is to open up the impact of such parochial testing and reporting regimens and to make a case for a view of Aboriginal and Torres Strait Islander students as multi-numerate rather than "numeracy impaired".

The "official" image of Aboriginal and Torres Strait Islander students in Australian schools is one essentially of ineducability, there being perhaps no more indicative program title than *Closing the Gap* to reflect this deficit view of the educational capacities of Australian indigenous students. The then Prime Minister's (Tony Abbott) opening statement in the *2015 Closing the Gap: Prime Minister's Report* makes it very clear that the official narrative of learning is tethered to formal Western senses of what and where it means to be educated: "*It's hard to be literate and numerate without attending school*" (Australian Government, 2015: 2). This report starkly acknowledges a failure on the part of the myriad projects nestled together under the "*Closing the Gap*" funding banner to make any real progress towards the 2018 target of halving the gap between the reading, writing and numeracy achievements of non-indigenous and Indigenous students, (untypically) confessing that "*There has been no overall improvement in Indigenous reading and numeracy since 2008*" (Australian Government, 2015, p. 4). The unwritten ending of this statement is probably along the lines of "despite governments spending large amounts of money over many decades on this". If the commitment of government—and by extension, the community as a whole—hasn't been wanting, then the problem must surely lie on the side of the recipients of this social concern and consequent financial largesse. There must be, goes the logical extension here, an inherent problem, lack or deficit in the cognitive capacities of Aboriginal and Torres Strait Islander people. They simply aren't able to learn these things, or, at least, those things required by the school curriculum.

An interwoven discourse surrounding the casual factors of indigenous learning deficit is that of environment. One might see all of the facets of "environment" as falling within the general purview of the notion of cultural capital, particularly in the complex constellation of two of the three forms in which such capital manifests and exists:

> in the embodied state, i.e., in the form of long-lasting dispositions of the mind and body; [and] in the objectified state, in the form of cultural goods (pictures, books, dictionaries, instruments, machines, etc.) (Bourdieu, 1986: 243)

In other words, in this discursive regime, the learning deficits of Aboriginal and Torres Strait Islander students are the product of a lack of the types of cultural knowledge, expertise and material possessions sufficient to connect with the ways of knowing and being expected, required and taught by the formal schooling process. As such, these students lack the cultural capital necessary to secure social and economic normalcy, legitimacy, acceptance, and in the logic of the dominant culture, success.

Intertwined, these two narratives of indigenous ineducability paint pictures of contemporary forms of the primitivism and sub-human status that has marked previous depictions of Aboriginal and Torres Strait Islander peoples. In one very thorough historical exploration of the representations of indigenous peoples in the Australian context, Sharp (2010) analysed the representations of Aboriginal Australians in official syllabus and associated teaching materials (textbooks, school papers, children's storybooks, etc.) used in Queensland schools over an approximately 100-year period. Whilst she was looking largely at the history curriculum, Sharp's summation of the place of Indigenous Australians in the official school narrative of nationhood is important here:

> Indigenous Australians are not excluded from the narrative, although their inclusion is constructed based on a passive and subjugated identity (2010: 410)

In her study, Sharp identified persistent themes in official school materials that are highly relevant to the point being made here. She identified what she called discourses of Indigenous Australians as being "savages/primitives" (2010: 309), "monocultural" (2010: 358), "on the fringe of history" (2010: 352), and presenting as "problem-laden" (2010: 357). The crucial point is that over an extended time period, generations of children have absorbed ("learned") certain things about Aboriginal and Torres Strait Islander peoples; teachers have presented ("taught") such problematically one-dimensional and culturally-sectional ideas about Indigenous Australians; and Aboriginal and Torres Strait Islander peoples have come to see themselves represented in these ways repeatedly and consistently in the various forms of official knowledge (Apple, 1993).

This last effect is a major tool in the armoury of colonisation and both leads to and reinforces the intergenerational alienation of Aboriginal and Torres Strait Islander peoples from their cultures and ways of life. The power and impact of a process of learning to see oneself as seen by dominant forces in a society has been the focus of attention and concern for well over a century, from du Bois' notion of double consciousness (*this sense of always looking at one's self through the eyes of others, of measuring one's soul by the tape of a world that looks on in amused contempt and pity*). Du Bois (1903: 9) to Franz Fanon's exhortation to the colonised to pursue what he called resistance to cultural amputation (Fanon, 1967: 140) (*resisting the colonizing knowledge system that constantly pathologizes and criminalizes blackness and misrepresents it as an agent of malevolent powers there to* *cause harm to the white world*) (Adjei, 2010: 87) to Albert Memmi's analysis of *the colonialist hoax* (Memmi, 1967: 91).

In the Australian context, Nakata (2007b), writing from a Torres Strait Islander perspective, comprehensively charts the development of Western knowledge about and representations of Torres Strait Island peoples and cultures that flowed from the activities of various agents of colonisation—religious, scientific (especially anthropological) and educational—that for all intents and purposes has come to assume the non-partisan status of "knowledge":

> My task was not simply to know my position but to know first how I was positioned in and by Western disciplines and knowledge practices. My task then was to know how such a knowledge system created a position for Islanders through which we have all come to view Islanders and their problems. (2007b: 11)

A further significant piece of work relevant to the arguments of this chapter is that of Australian sociologist, Raewyn Connell in her book *Southern Theory* (Connell, 2007). Connell's purpose in this particular book was to explore the ways in which academic disciplinary knowledge—particularly that of sociology—developed from a Western center, mirroring the physical exploitation of the colonized worlds [mining, plant and animal trafficking, etc.] through the ways in which it effectively "mined" non-Western knowledge resources and proclaimed the output as its own. In the pursuit of such an appropriation of intellectual resources of the colonized world, Connell argues, the power and significance of such intelligence resident within the Periphery (the colonised) had to be largely rendered invisible or at the very least, derided as primitive or superficial. One can see this strategy in place with regard to Australian Indigenous knowledge systems and ways of knowing, and arguably this process continues apace through the application of Western-based processes of assessment, evaluation, and categorization of Indigenous peoples as holding both an inferior "traditional" or cultural knowledge and a seeming inability to "succeed" within the Western canon.

What does this mean to you as a teacher of numeracy?

- What hidden images and presuppositions of Aboriginal and Torres Strait Islander people and students do you unthinkingly bring to your educational practice?
- Do you subconsciously conflate a culturally-specific way of knowing with a universally-applicable way of knowing that you assume applies to everyone, worldwide?
- How does the formal curriculum you work with reflect an understanding of multiple and differing knowledge systems and ways of knowing and acting on the world?

To flesh out further the situation regarding Aboriginal and Torres Strait Islander students, and to use the current dominant language of assessment—statistics—we can draw out a number of clear-cut conclusions regarding the constructed reality of learning, in this particular case in the area of numeracy, of Indigenous Australian students. The primary source of such statistical—and thereby accepted commonsensically as apolitical and objective; that is, "accurate"—knowledge is the annual National Assessment Program—Literacy and Numeracy (NAPLAN). The annual NAPLAN tests have been visited upon students, teachers and schools since 2008, and are claimed to test achievement in *the sorts of skills that are essential for every child to progress through school and life, such as reading, writing, spelling and numeracy* (ACARA, 2013).

What do current statistics tell us about the numeracy competencies—a.k.a. learning achievements—of Aboriginal and Torres Strait Islander students? Drawing from the most current set of figures available at the time of writing, the 2014 NAPLAN Report (ACARA, 2014), Indigenous Australian students fall behind their non-indigenous counterparts across all of the several areas of testing. In the area of Numeracy, the official image of Aboriginal and Torres Strait Islander students tells us that:

- 76% nationally meet expected standards in numeracy compared with non-indigenous students, 95.2% of whom meet these standards;
- this disparity is consistent across the four school years of NAPLAN testing [years three, five, seven, and nine];
- the percentage of Australian Indigenous students meeting minimum expectations in numeracy decreases markedly across the four geographical regions—metropolitan, provincial, remote, and very remote. 82% of Indigenous students in metropolitan areas meet minimum numeracy standards as opposed to 41% in very remote areas; and that
- less than 41% of Australian indigenous students in very remote areas meet minimum numeracy standards compared to 94% of nonindigenous students in the same geographic regions.

So, from within this particular paradigm it would seem—in fact, is proven—that Aboriginal and Torres Strait Islander students are significantly challenged in the understanding of the basic tents of numeracy, and the more removed from urban areas students are, the more significant the challenge. As such, these statistics present as major markers of an educational crisis, with all of the attendant impacts on and consequences for life chances. The fact that there has been no improvement in these "objective" measures of numeracy over many years, despite the dedication of many millions of dollars, points to a underlying assumption of an Australian Indigenous incapacity to think or reason numerically. But is this the total picture, and how should educators respond to such statistics?

What does this mean for you as a teacher of numeracy?

- In what ways has the non-problematised use of purely statistical measures become "standard procedure" in the professional preparation of educators?
- What is lost in the translation of (subjective) human experience into (objective) statistical descriptors?
- What cultural and educational violences are perpetuated through reports such as NAPLAN?
- Beyond the capacity to digest statistics, what professional preparation, processes, knowledges and orientations are necessary for teachers to work more authentically and respectfully with Aboriginal and Torres Strait Islander students?

In the rest of this chapter, I look to address issues of the cultural situatedness of what many might take as an unproblematic universal: the epistemological, conceptual, and lexical processes of enumerating the world from a Western worldview or perspective. In particular, I endeavour to expose and explain the political underpinnings of a particular way of knowing the world—Mathematics—and to suggest that at least two groups of students typically identified as being "behind" in most areas of the formal school curriculum—viz. Australian Aboriginal and Torres Strait Islander students—inhabit and straddle multiple and complex cultural and educational lifeworlds (Guy, 2015), the successful navigation of which requires adeptness at what might be seen to be a numerical version of the originally linguistic concept of code switching:

> In general terms, codeswitching can be used to refer to situations in which bilingual people alternate between languages, either between or within utterances. (Greer, 2007: 28)

The importance of the concept of lifeworlds to considerations of matters such as the numeracy learning of Aboriginal and Torres Strait Islander students cannot be overstated. Jill Guy, in her doctoral thesis that set out to explore the complexity of education and schooling of young Australian Aboriginal males, provides a useful summary of this phenomenon:

> A lifeworld is a "communicative locale for affirming individual agency and forming cultural identity" (Ludert, 2010: 3). Husserl explained the lifeworld as the world of human activity and everyday sociability, taken-for-granted and always there as a background to other dimensions of life (Husserl, 1982). According to Nakata (2002) Aboriginal and Torres Strait Islanders' lifeworlds are situated in a cultural interface, a complex intersection of Indigenous and Western epistemological domains. It is the place where we live and learn, the place that conditions our lives, the place that shapes our futures and more to the point the place where we are active agents in our own lives, where we make decisions (Nakata 2002: 285).

In this intensely personal research project grounded in the very concrete experiences of her participants, Guy documented the significant tensions experienced by these young Australian Aboriginal people as they tried to move effectively between and within Aboriginal and Western educational contexts. Clearly, there is not space within the confines of this chapter to delve more deeply into the specifics of Guy's research, but the crucial point for this current chapter might well be summed up by quoting from her concluding section:

> The participants within this project highlighted some of the challenges that are experienced with biculturality within Australia. There are many people, not only Aboriginal and Torres Strait Islander peoples, who inhabit complex educational lifeworlds that are comprised of more than the white, middle class cultural capital that is promoted within the formal schooling arena. It appears as if many of these people will continue to experience the educative tensions that arise when these worlds clash, unless action is taken to change societal views. The cultural interface, the site where the Indigenous and Western epistemological domains meet (Nakata, 2002) has the potential to create a vibrant, strong and empathetic Australia. (Guy, 2015: 172).

What does this mean for you as a teacher of numeracy?

- In what ways do notions of bi- or multiculturality, lifeworlds and codeswitching complicate generalised statements about Aboriginal and Torres Strait Islander students (and other groups from other than Western backgrounds)?
- How might teachers accommodate and support students for whom codeswitching is a constant aspect of their educational experiences?
- What are the educational benefits of ensuring all students, especially those from a dominant cultural background, experience life through a codeswitching lens?

The Multiplicities of Knowledge Systems

From the perspective of official views of numeracy, how does this clash of or tension between two educational or knowledge systems manifest in the context of Aboriginal and Torres Strait Islander peoples' education? In this section, I hope to provide an example or two to demonstrate the significant differences between ways of enumerating [in a Western sense] the world. There are some caveats that must be applied at this point, however.

Firstly, Australian Indigenous peoples inhabit many distinct and frequently diverse cultures, therefore it is not justifiable to generalize about "Aboriginal culture". Each particular group or mob will have very specific ways of seeing and being in the world, such that to collapse all of these cultures into one clearly continues a process of erasure. The examples I use below are drawn from conversations with and observations of members of the Bana yarralji people of Far

North Queensland. Secondly, as a non-indigenous person, I can be shown or have explained to me only certain aspects of local indigenous knowledge. Consequently, one must always understand that there will be significantly deeper layers of meaning and knowledge that operate to structure and advance a particular Indigenous culture that are literally "unknowable" to those outside that culture. Further, even those within a particular culture may not have access to all various levels of such knowledge and understanding. The continuing process of the alienation of Australian Indigenous peoples from their cultures means that particular cultural educational milestones [initiations etc.] have not occurred. Such cultural education is typically the province of the Elders, many of whom are now desperate to have members of their mob return to country to receive requisite knowledge and understanding to ensure the survival and development of that culture.

As with any means of capturing and describing the world, mathematics is a specialist language system in the same way as the many spoken languages of the world. This includes various scientific symbolic squiggles and the symbolic codes of cartographers, for example. The current knowledge systems underpinning the formal school curriculum in Australia are derived from the Western/European Enlightenment period, which saw the rise to ascendancy of Cartesian-Newtonian ways of seeing and coming to know the world and to explain reality. The tradition of Enlightenment thinking, in very severe summary, revels in the task of asserting the dominance of the human over the natural.

The point of science, in the first instance, is to ensure the control, manipulation and bending of Nature to human will. Essentially, this requires the development of technologies of control that are based upon requisite processes and procedures that seek to uncover Laws of Nature and expose them to the control of the Human. Such law-seeking activity requires the dismantling and dissection of phenomena, their reduction to smaller and smaller pieces or parts, and their subjection to the application of the Scientific Method—the identification and control of variables, experimentation, and the prescription of treatments to effect desired change. All of this, of course, requires a precision and succinctness of recording and description. Mathematics clearly is one of the systems of discovery and representation that fits such a bill, and from this fit derives the place of Mathematics and numeracy (as a form of literacy) in Western schooling curricula.

> [The E]nlightenment is founded upon the drive to master and control nature. The realization of this aim requires the ability to cognitively and practically manipulate the material environment in accordance with our will. In order to be said to dominate nature, nature must become an object of our will. Within highly technologically developed societies, the constraints upon our ability to manipulate nature are typically thought of in terms of the development of technological, scientific knowledge: the limits of possibility are determined not by a mythical belief in god, say, but in the development of the technological forces available to us. (Fagan, 2015: 8)

The ascendancy of Western ways of thinking and thought required and paralleled the derogation of other knowledge systems, through such strategies as the primitivisation and infantilising of such Other knowledge systems, painting indigenous peoples as lacking in reason and rationality and beholden to magic, myth and mystery as lenses through which to see and know their worlds.

It is important to maintain a focus on this particular point: what has become “naturalised” as the way things are is but the current (and temporary) acceptance of a very parochial and, consequently, partial or incomplete way of seeing the world. It is not an enduring transcendental Truth, but one way of many of proclaiming tentative truths. What is lost in this project of the universalisation of Western ways of knowing is the presence of many other ways of knowing that are not quaint remnants of bygone times but robust living and evolving knowledge systems that retain currency with many of the world’s people.

What does this mean for you as a teacher of numeracy?

- How have and are ways of knowing or knowledge systems that differ from dominant knowledge been portrayed in educational materials?
- In what ways are broader social, cultural, scientific and economic agencies incorporating Other knowledges?
- What are the personal issues attaching to an acknowledgement by teachers that the knowledge system within which they have been academically and professionally successful are but partical and biased, rather than universal?

The partiality or sectional nature of Western ways of knowing has been much commented on, Zeus Leonardo succinctly describing the universal masquerade of this parochial way of seeing, describing and representing the world:

> Western epistemology and philosophy arose from the particularities of European culture and understanding. They are insightful, at times critical, but always partial like other ways of thinking. They are partial for two reasons. First, they are partial in the sense that Western thought represents a slice of understanding, not its whole. Second, they are partial because they articulate a preferred way of comprehending the world, that is, a politics. When it is constructed as the universal standard for rational thought and derogate worldviews of colour in the process, European thought takes on a racial dimension. (Leonardo, 2009: 3)

Indigenous knowledge systems and Western knowledge systems work off different theories of knowledge that frame ‘*who can be a knower, what can be known, what constitutes knowledge, sources of evidence for constructing knowledge, what constitutes truth, how truth is to be verified, how evidence becomes truth, how valid inferences are to be drawn, the role of belief in evidence, and related issues’* (Gegeo & Watson-Gegeo, 2001: 57).

In a very summary form (and with apologies to more mathematically-oriented and-knowledgeable readers for the simplification here), Western mathematics and numeracy rely on a number of processes, with abstraction, standardisation and precision being the more prominent of these. In order to convert the concrete to the numerical, the idiosyncratic features of a particular environmental phenomenon need to be shed to expose the core or central issue or feature under investigation. The removal from the concrete and relocation into an abstract form is the province of the application of “objective” formulae, rules and algorithms. Only once such abstraction has occurred can the application of standardised means of dealing with the mathematics involved proceed. This requires precision as measured, represented and described by finer and finer points of calibration: the more narrow the measure, the more focussed and, therefore, accurate an enumeration is. The depersonalisation of abstraction is obviously present whenever symbols push the personal off the page: $x + y = z$.

By comparison, other ways of speaking about the world in a language of quantification retain, of necessity, the connection to the concrete—the social, cultural, spiritual and environmental dimensions of life. In the conversational exchange at the very beginning of this chapter, a very different use of quantitative language is evident, and presents as a good example of a non-standardizing, imprecise, culturally-grounded and concrete numerical literacy. In that snippet of conversation, the language is clearly imprecise from a Western mathematical point of view. The word “enough” conveys a less-than-acceptable response to the question “how many?” for Western purposes, yet clearly connects the numerical/quantitative to the social and cultural. Not only does the word “enough” speak to the feeding of a gathering, it also reflects environmental concern to take only what is necessary and possibly to the totemic dimension as well: the need for those of that totem to protect and ensure the well-being of the magpie goose.

I am assuming that the hunting party took into account the size of each goose as it was captured, and not relied on a basic standard size of a magpie goose when deciding they had caught “enough”. In Western mathematical ways, the problem of how many geese would be needed would likely be solved by the application of an abstracted mathematical procedure:

- If 1 magpie goose will feed 2 people, and 50 people have to be fed, how many geese will we need?
- 50 (people) in groups of 2 (per goose) = 25 geese needed
- 50/2 = 25

Hopefully, this simple example demonstrates the shedding of all cultural and social connections and considerations in the application of Western mathematical ways to the solution of the problem. This way of representing the situation at hand reflects clearly the abstraction, standardisation and numerical precision described earlier.

Additionally as imprecise for Western curriculum and NAPLAN-type purposes, the response to the question of how many people attended the gathering—“*everyone, everyone came*”—reflects a totally different way of capturing quantities. It is obvious to those familiar with the specific cultural context who would be attending, so there is a form of cultural precision that is imperceptible to those outside that context. There is also a clear cultural dimension in the added comment about the sharing of the food after the event that adds further layers of cultural complexity to what to many in the formal schooling system might see as a very simple numerical task. Where Enlightenment-sourced Western mathematics cuts the social into smaller and smaller pieces in order to understand, control and change, Australian indigenous ways focus on the holistic, on the big-picture interrelationships that bind the human to the natural, the individual to the social. Another example of the clear difference between these two ways of naming the world is the use of the word "soon" to determine a temporal reading of a situation, possibly in relation to the question "when?". Again, "soon" is far too imprecise for school curriculum purposes, yet it carries a complexity of meaning and possibilities that far exceed the simple reading of a chronometer of some sort. It is between these two mathematical lifeworlds that many Aboriginal and Torres Strait Islander students tread, but it is only within one of these lifeworlds that the numerical or mathematical competence and overall educability of these students is determined.

This stepping from one into another lifeworld and back again—codeswitching—is a competence on display continually. Within the conversation from which the snippet presented above was extracted, the language used switched from the culturally-appropriate to the use of terms like kilometres (to the next township), kilograms (the size of a local saltwater crocodile), and hectares (the size of an area of country to be subjected to a traditional burning off as Spring approaches). This marks out everyday life for Aboriginal and Torres Strait Islander peoples at Nakata's (2002, 2007a) cultural interface.

What does this mean for you as a teacher of numeracy?

- What do the ideas in this chapter mean for a "teach the textbook" approach?
- How practical is a focus on the specific cultural background and its educational implications of each student in a classroom?
- Should teachers be concerned more with covering the material specified in curriculum documents and tested via standardised tests than with ensuring student cultural and educational needs are met?
- What would life in classrooms and schools be like if needs replaced content as the driving force in teachers' professional decision-making?
- What political obstacles would hinder a concern for Aboriginal and Torres Strait Islander student educational well-being being manifested in everyday pedagogical practice?
- Can teachers afford to eschew the political dimensions of their professional lives?

Multilogicality

How might educators deal with this multicultural fact of life for Aboriginal and Torres Strait Islander students, this "toggling" (Nakata, 2007b, p. 10) of epistemological and practical positions? The current systemic approach is to largely ignore knowledge or ways of knowing that are not of Western origins, or, if not to ignore, then to dispatch those other knowledges to the realms of museum or myth. The Australian Curriculum shows scant regard for the millennia old traditions of knowledge production from indigenous cultures as alternative ways of knowing to that of the (currently) dominant Western way. Aboriginal and Torres Strait Islander peoples' ways of knowing effectively provide little more than a quaint distraction from the real content of school education. An alternative approach to this quandary for educators wishing to extend respect to such alternatives or who wish to engage practically in the process of reconciliation at present working its way through the broader national community might well lie in what Joe Kincheloe and Shirley Steinberg called "multilogicality": where *we begin to see multiple causations and the possibility of differing vantage points from which to view a phenomenon* (Kincheloe & Steinberg, 2008: 138).

Essentially, Kincheloe and Steinberg envision the multilogical educator to be one who moves from one epistemological base to another, able to draw from changed vantage points, vistas and political emphases so as to better consider both the complex nature of lived experience and the problems, challenges and possibilities that reside therein. The critical multilogical pedagogue is cognizant of the value of *learning from the vast storehouse of indigenous knowledges that provide compelling insights into all domains of human endeavor* (Kincheloe & Steinberg, 2008: 135). In other words, educators concerned to effect a genuine position of multicultural respect

> work to extend their students' cognitive abilities, as they create situations where students come to view the world and disciplinary knowledge from as many frames of reference as possible. They seek more than one perspective - they seek multilogical insights (Kincheloe & Steinberg, 2008: 139)

Adopting a multilogical orientation means that, in this particular case, indigenous knowledges and ways of describing the world numerically are viewed as different from rather than deficient compared with Western knowledge. It means accepting and working with the notion that the form of knowledge and the means of expressing that knowledge contained in the current Australian curriculum reflects a position of contemporary dominance, not a position of Universal Truth or "naturalness". Such a pedagogical commitment from educators requires a pedagogical acknowledgement of the validity of Aboriginal and Torres Strait Islander peoples' knowledges rather than condemning them to the epistemological waste bin of superstition.

If anything further is required by way of persuasion of how imperative it is that educators learn to work with multiple forms of knowledge, the words of Vandana Shiva, Indian social justice and environmental activist and recipient of the 2010 Sydney Peace Prize, add yet another dimension to this:

> The main threat to living with diversity comes from the habit of thinking in terms of monocultures… Monocultures of the mind make diversity disappear from perception, and consequently from the world… Monocultures first inhabit the mind, and are then transferred to the ground. Monocultures of the mind generate models of production which

> destroy diversity and legitimize that destruction as progress, growth and improvement. Monocultures spread not because they produce more but because they control more…Local knowledge systems throughout the world have been conquered through the politics of disappearance, not the politics of debate and dialogue (Shiva, 1993: 5–9)

What does this mean for you as a teacher of numeracy?

- How would your own knowledge base stand up to the challenges presented in this chapter?
- Do you have the civic courage (as Henry Giroux terms it) to look to effect genuinely inclusive practices and culturally appropriate pedagogies in your classroom?
- Which is more important for a sustainable, just and respectful society: diversity or standardisation?

Conclusion

Arguably, today's Aboriginal and Torres Strait Islander students are the current generation of victims of a process, commenced during initial periods of colonisation and continuing through to the present, that seeks to embed an unthinking belief in the superiority of the coloniser and the obverse view of the colonised. Contemporary practices reinforcing such a hierarchy of cultural worth include national curricula based solely on and containing almost exclusively coloniser content as the knowledge or skills to be taught and learnt, and on the increasingly significant weight placed upon standardised testing programs—NAPLAN as but one example—that ultimately drip feed the discourse of deficit and ineducability of Aboriginal and Torres Strait Islander peoples. In the hectic workplace that educators inhabit, with already overcrowded curriculum areas to be accommodated and added to (at the time of writing, it is highly likely that developing skills in computer coding will be the next area to be shoehorned in), there is little time for professional education and development in anything other than what is accorded the label of "essential" or "core business" of the neoliberal school. The argument I have put forward in this chapter is that Aboriginal and Torres Strait Islander students learn far more than is ever tested or even acknowledged in the formal school curriculum. Rather than being "ineducable" or behind the rest of the population in terms of learning outcomes, such students are actually skilled in at least two different cultural contexts—their home culture and that of the Western-based schooling system. These students are literate, in all senses of the word, in the ways of a number of cultures, but are "judged" only by their proficiency in one of those.

As such, I would argue the case for a reconsideration of what constitutes the "essential" work of the school and, consequently, the professional development and education of its teachers, to ensure the basic elements of Kincheloe and Steinberg's notion of multilogicality find their way into a genuinely multicultural pedagogy of respect and inclusion. There are many promising signs of such a shift, particularly in those schools located on-country where principals and their staff work closely, if tentatively, with local Elders to try to ensure a respect, an accuracy and a presence of and for local Aboriginal and Torres Strait Islander peoples' knowledges to find their way into the daily life of the school, thereby better positioning Australian indigenous students to remain connected to their home culture whilst learning to negotiate their way within dominant culture with dignity and confidence; in other words, to embrace wholeheartedly the effervescent world of Nakata's Cultural Interface. The next step, of course, is to open up ways for dominant culture students to experience the same exhilaration and personal development, otherwise it might well be the case that a quite different sense of "closing the gap" will need to prevail.

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Language and Culture in the Mathematics Classroom: Scaffolding Learner Engagement

Rachel Burke

The Language and Culture of Mathematics

Various assertions have been made regarding the relationship between mathematics, language and culture (Barwell, 2002; D'Ambrosio, 2001; Fogelberg et al., 2008; Guberman, 1999; Ladson-Billings, 1997; Lesser & Blake, 2007; Street, 2003). Some posit a dichotomous relationship, understanding mathematics to be separate to language and culture. Others refer to mathematics as 'the universal language', consisting of conceptual knowledge and cognitive processes common to all cultural and linguistic groups.[1] However, since the 1970s, researchers have increasingly identified both the language-like nature of mathematics itself and the role of language within the mathematics classroom (Armstrong & Rogers, 1997; Clarkson, 2007; Halliday, 1978; Jamison, 2000; Kenney, 2005; Monaghan, 2009; Moschkovich, 2007; Pimm, 1987; Schleppegrell, 2007).

Further, awareness of the cultural situatedness of mathematics as a discipline has increased with research in the areas of ethnomathematics, critical numeracy and mathematical history (D'Ambrosio, 2001; François, 2009; Lesser & Blake, 2007; Powell & Frankenstein, 1997). This research has generated consciousness of the contribution of many cultures to the evolution of mathematics, the diversity of mathematics as it is practiced in a variety of cultural contexts today and the importance of learners engaging with mathematical content in meaningful,

[1] Although these concepts and processes are usually articulated according to a normative, 'Western tradition', here, it is acknowledged that many of the concepts commonly associated with the 'Western tradition' of mathematics have their origins in India and Northern Africa, and that many cultures have contributed to the development of what has come to be defined as 'the mathematics discipline' (D'Ambrosio, 2001).

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personally relevant, culturally rich ways (Ascher, 2002; Brandt & Chernoff, 2014; Cummins, 1996; Guberman, 1999; Ladson-Billings, 1997; Lessor & Blake, 2007; Matthews, Cooper, & Baturo, 2007; Moschkovich, 2002; Moschkovich & Nelson-Barber, 2009; Orey & Milton, 2007; Street, 2003).

For learners from English as an Additional Language/Dialect (EAL/D) backgrounds, mathematical education in the Standard English[2] as a medium of instruction (MOI) context may present a dual challenge; the acquisition of important numerical concepts occurs simultaneously with the acquisition of the target language and cultures. Depending on the learner's level of proficiency in Standard English, appropriate teacher scaffolding is necessary to prevent the linguistic burden associated with mathematics education from impeding the development of essential numerate knowledge and dispositions. As the Australian National Numeracy Review Report of 2008 (Council of Australian Governments: 34) advocated,

> the language and literacies of mathematics [must] be explicitly taught by all teachers of mathematics in recognition that language can provide a formidable barrier to both the understanding of mathematics concepts and to providing students access to assessment items aimed at eliciting mathematical understandings.

This chapter will provide information on some of the key linguistic and cultural aspects of engagement with mathematics in the primary Standard English as an MOI classroom. There will be a particular focus on teaching strategies for scaffolding learner participation across a range of English language proficiency levels and cultural contexts. Practical examples will be provided to illustrate how the concepts discussed may be applied to the primary classroom context.

What is an EAL/D Background?

The Australian Curriculum and Reporting Authority (ACARA) (2014a, 2014b: 6) advises that the term 'EAL/D' refers to 'those whose first language is a language or dialect other than English and who require additional support to assist them to develop proficiency in English'. Accordingly, the term 'EAL/D' relates to a diverse population of learners, with varied linguistic and educational experiences and needs. ACARA (2014a, 2014b: 6–7) recognises this linguistic and cultural complexity, asserting that EAL/D students

> "come from diverse multilingual backgrounds and may include:
>
> - overseas and Australian-born students whose first language is a language other than English,

[2]The term 'Standard' is used here to refer to the dialect of language often privileged in schooling. It is acknowledged that there are many varieties of English and learners with an EAL/D background may be highly proficient speakers of a number of these dialects.

- Aboriginal and Torres Strait Islander students whose first language is an Indigenous language, including traditional languages, creoles and related varieties, or Aboriginal English"

Given the diversity associated with the term 'EAL/D', there is no one approach for maximising learner outcomes. Rather, different learners will present with distinctive knowledge, linguistic expertise and educational needs according to their unique cultural and linguistic circumstances. All learners with an EAL/D background will have particular educational experiences, although some will have also undertaken formal schooling, whilst others may have encountered minimal or interrupted schooling. Some learners will be highly proficient in oral literacy and/or expertly code switch between dialects according to context. Some learners will have had refugee experiences, whilst others will have been born in Australia. Importantly, EAL/D learners may be fluent in the language of instruction and require little linguistic assistance, or they may be absolute beginners and need extensive support. Regardless, each learner brings a unique cultural, social and linguistic perspective to the mathematics classroom.

Scaffolding in the mathematics classroom allows multilingual/multidialectal learners to maximise their educational outcomes, both in terms of mathematical development and language acquisition. Scaffolding may be conceptualised as the provision of

> contextual supports for meaning through the use of simplified language, teacher modeling, visuals and graphics, cooperative learning and hands-on learning (Ovando, Collier, & Combs, 2003: 345).

The provision of individualised scaffolding for learner engagement with mathematics necessitates knowledge of the specificities of mathematical language and an understanding of the individual learner's level of proficiency in Standard English (where Standard English is the MOI). The latter requires teachers to conduct thorough pre-assessment and needs analysis in order to determine each learner's English language proficiency level and learning strengths and requirements. It may be helpful to research learners' home languages and dialects, to consider the social and cultural functions of language in these contexts, and to reflect on the way learners communicate about mathematics outside of the classroom (Barwell, 2008; Moschkovich & Nelson-Barber, 2009). This type of needs analysis allows teachers to structure classroom learning from familiar to less familiar content, and to utilise learners' existing knowledge, skills and experiences as an important foundation. Some schools also have EAL/D advisors to help teachers evaluate learners' language proficiencies and plan for comprehensive, individualised assistance across the curriculum.

Importantly, communication for mathematical purposes in formal schooling generally occurs within an academic context (Halliday, 1978). Cummins (1984) has differentiated between the process of language learning for Basic Interpersonal Communication Skills (BICS) and for Cognitive Academic Language Proficiency (CALP), stating that the former may develop within 2 years of immersion in the target language, while learners may require between 5 and 7 years of immersion in order to navigate academic language at the same proficiency level as their Standard English-as-a-first-language background peers (for Standard English as an MOI context). Therefore, basic interpersonal language skills are insufficient indicators of a learner's cognitive academic language expertise (Cummins, 1984). A learner's 'playground talk' may belie the difficulties s/he experiences with more abstract, specialised language forms encountered in the mathematics classroom.

What does this mean to you as a teacher of numeracy?

- The term English as an Additional Language/Dialect (EAL/D) is used to refer to a diverse group of learners with a range of linguistic and cultural experiences and circumstances
- Some learners will be fluent in Standard English, whilst others may require extensive support in a Standard English as a Medium of Instruction (MOI) context
- An understanding of the linguistic and cultural requirements of engaging with mathematics in the primary classroom can assist teachers to scaffold learner participation.

Specificities of Language in Mathematics Education

Derewianka and Jones (2012: xiii) advise

> We learn through language. Our knowledge about the world is constructed in language – the worlds of home and the community, the worlds of school subjects, the worlds of literature, the worlds of our workplace, and so on.

Accordingly, understanding the role of language in the mathematics classroom and how mathematical relationships are 'brought into being through language' (Barwell, 2008: 2) is an important component of teaching the subject. It is insufficient for educators to simply 'know' a language; they must also know *about* it and have a comprehensive understanding of its complexities, dimensions and features. Appropriate scaffolding of learner engagement with mathematical content requires expert knowledge of the various language features involved, from lexical terminology through to an awareness of typical grammatical forms.

There is an extensive body of research exploring the unique ways in which language functions within the mathematics classroom (Clarkson, 2007; Halliday, 1978; Jamison, 2000; Kenney, 2005; Kotsopoulos, 2007; Pimm, 1987; Schleppegrell, 2007). Among the key contributors to this field of enquiry is Halliday (1978), who provides a systematic treatment of the 'mathematical register'. The register refers to the 'set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings' (Halliday, 1978: 195). The mathematical register therefore refers to the characteristics and conventions of language that are privileged in mathematics, given the subject matter, purposes and audiences for communication. Halliday (1978) asserts that the numerate practices undertaken in daily life feature different language requirements to the more specialised terminology of the mathematics classroom. Yet, learners are often expected to acquire the mathematical register without explicit attention to the particular language features and systems for conveying meaning.

Accordingly, in addition to the underlying mathematical concepts central to the Australian national primary curriculum and expressed in the content strands of 'number and algebra', 'measurement and geometry' and 'statistics and probability' (ACARA, 2011), there is a need for directing explicit attention to the language practices required to engage with this content knowledge. Such attention to language forms is essential for all learners; however, the unique linguistic and cultural experiences of students with EAL/D backgrounds may generate particular advantages and challenges for their navigation of Standard English MOI contexts and may necessitate individualised instructional support.

Engaging with Signs and Symbols

Can you answer this question?
El caballo marrón viaja durante 20 minutos desde el establo hasta el lejano prado a una velocidad de 15 km por hora. ¿Cual es la distancia entre el establo y el lejano prado?

This task is designed to illustrate that, without a thorough and clear understanding of the language used to convey mathematical information, learners may struggle to engage with essential theories and cognitive processes. Further, teachers may encounter difficulties in ascertaining whether learners have gaps in their mathematical or linguistic proficiency (or both). If you were unable to answer this question, were there any parts of the task that you were able to understand? What additional support did you require? If you were able to answer the question, what linguistic skills, prior knowledge about such texts, or familiarity with mathematical operations did you utilise?

Perhaps, the most obvious component of mathematical language is the specialised vocabulary required to engage with underlying concepts. As Schleppegrell (2007: 147) has noted 'The explanations textbooks provide tend to be dense, so the teacher plays a key role in helping students learn to negotiate the symbols, diagrams, and technical language'. For a useful compilation of specialist terms throughout the mathematics curriculum, see ACARA's (2014a, 2014b) *Annotated Content Descriptors for Mathematics*. This guide provides information on the linguistic and cultural aspects of the mathematics curriculum that may prove challenging for learners. The suggested teaching strategies are useful for all learners, not only those from an EAL/D background.

Some mathematical terms contain indications of their meaning, for example, 'triangle', and so provide clear links between the word and the concept (ACARA, 2014a, 2014b). It can be useful to draw learners' attention to these textual cues to assist them to develop their 'code breaker' skills (Freebody & Luke, 1990; Watson, 2014). However, the definitions of other key specialist terms in mathematics are less apparent and may present a challenge to some learners. Not only are such terms less likely to be used outside of the mathematics classroom, but also many of these words have their origins in Greek and Latin which may add an additional layer of complexity (Halliday, 1978; Kenney, 2005). As Halliday (1978) points out, mathematical English includes many words derived from other languages including Latin ('subtract', 'series', 'acute', 'frequency' and 'apex'), French ('domain', 'cone', 'gradient', 'correspondence', 'dividend', 'symmetry' and 'cylinder') and Greek ('isosceles', 'prism' 'logarithm' and 'pi'). Depending on the learner's language background, some of these words—or their linguistic origins—may be familiar. In other cases, learners may require support to acquire this subject specialist vocabulary.

Addressing subject specialist terminology requires attention to the phonological, grammatical, functional and semantic content of each word (Nation, 2001; O'Keeffe, McCarthy, & Carter 2007). Teaching the skills for using contextual cues to determine the meaning of unfamiliar vocabulary is an important element. For example, students with adequate English language proficiency might be encouraged to think about the grammatical role of the word 'array' in the following sentence: 'Using your knowledge of patterns, make an array'. Asking learners to think about whether the word 'array' is a noun, a verb or an adjective in this sentence and stating the reasons for their response will encourage them to activate background knowledge of syntactical rules in order to speculate on the meaning of the unknown vocabulary item. Drawing attention to other contextual cues, e.g. the word 'patterns', may also be helpful.

When a new vocabulary item is introduced, it can also be useful to draw explicit attention to the individual consonant and vowel sounds (phonemes) and the suprasegmental features at the word and sentence level, including stress, timing and rhythm (numeracy-related knowledge). Some teachers employ a 'rhymes with' approach, working with the class to discover rhyming words from their existing vocabulary to reinforce the pronunciation of new specialist terms or syllables within these terms. Rhyming words may be selected from any of the learners' languages and dialects and can also be represented in both written and illustrated forms to provide additional scaffolding.

Further, it is necessary to explore the grammatical features of each new specialist term, drawing attention to common collocations, tense and plural forms, prefixes and suffixes, and other morphological features that can alter the meaning of the word. Encouraging learners to construct colourful mind maps or word webs can be a creative way to display this mathematical language around the classroom. Cunningham and Allington (1994) suggest designing a 'word wall' in order to display important vocabulary, and the Victorian Department of Education and Early

Childhood Development (2009: n.p) has reported on the success of implementing Maths Talk Boards in primary classrooms to

> display the common mathematical vocabulary connected to the current maths learning focus. By having the same words used and displayed across classes, students feel the familiarity of consistent teaching and learning, and are able to associate more strongly with their past experiences.

Establishing a language-rich learning environment, with fun, interactive approaches to exploring specialist vocabulary, including the use of alliteration, rhymes, songs and movement, may be useful. Realia and the provision of real-world examples can provide paralinguistic cues for scaffolding learner understanding and enhance language acquisition through input that is meaningful and comprehensible (Krashen, 1981). Barwell, Leung, Morgan and Street (2002:15) recommend employing multimodal resources to engage with content in the mathematics classroom:

> By drawing shapes in the air, touching and feeling plastic objects and pointing to drawings on the board, children complement their language use by using other modalities – seeing, gesturing, touching. This is possible because the context provided by the teacher is one of exploration and of interactive social and linguistic relations…It is not enough for students to hear a few examples of a word being used or to be given a formal definition.
>
> They need to explore the concepts involved, push at the limits of definitions, change them, and most of all, make the meaning their own as they learn to talk mathematically.

Another important component of mathematical language is the use of common words to refer to mathematical concepts (Barwell, 2008; Hersh, 1997; Treacy, 2013). In contrast to their use in daily life, terms such as ‘mean’, ‘rational’, ‘square’, ‘volume’, ‘table’, ‘digit’, ‘product’, ‘scale’, ‘power’ and ‘plane’ acquire particular significance when used in a mathematical context. Again, teachers are required to help learners understand language as a system for making meaning in which individual signs (for example, words) may vary according to context. An example of such variation in meaning may be observed in the question, ‘How long is it until the end of the week?’ (ACARA, 2014a, 2014b: 4). Here, the word ‘long’ is used as ‘an abstract measurement of time’ rather than the opposite of ‘short’ (ACARA, 2014a, 2014b: 4). Homophonic forms such as ‘pair’ and ‘pear’, ‘ate’ and ‘eight’, and ‘sum’ and ‘some’ can also cause confusion and obscure learners’ mathematical abilities.

Activities that draw attention to ‘words that have special meanings in maths’ can be useful in assisting learners to understand the varied associations and definitions of vocabulary items across the curriculum and between the contexts of the classroom and everyday life. It may also be helpful to encourage learners to talk about their other languages/dialects and instances of ‘everyday words’ acquiring particular meaning in specialist contexts. It is important to frequently discuss and/or visually represent the ‘everyday meaning’ of vocabulary and the ‘maths meaning’, perhaps using different coloured fonts to record these definitions. At the same time, it is important to be aware that some learners may not use English in their home contexts, and therefore some of the ‘everyday words’ may also be unfamiliar.

Encouraging learners to express mathematical definitions and concepts in their own words (in whatever language or dialect they choose) and to discuss meaningful applications of mathematical knowledge to their own social and cultural contexts can also be valuable. This can be introduced in association with a 'mathematics vocabulary journal', in which learners can record key words, grammatical forms, pronunciation, first/other language and dialect equivalents, diagrammatic representations, and use in context, and can provide a helpful reference to be revisited regularly. Further, Barwell (2008) suggests students maintain journals describing how they feel about the numeracy skills they are learning. This provides a means of reinforcing mathematical concepts and associated language, while also reflecting on affective elements of learning (Barwell, 2008).

What does this mean to you as a teacher of numeracy?

- Assisting learners to acquire specialist vocabulary requires attention to the meaning, pronunciation, grammar and function of each word (Nation, 2001; O'Keeffe et al., 2007).
- Establishing a language-rich learning environment may involve displaying key mathematical vocabulary in word webs or mind maps, utilising realia, rhyme, songs and movement, and the provision of real-world, relevant examples and applications.
- Some mathematical words also have 'everyday' meanings. It is important to draw learner attention to the different ways language functions in different contexts, using techniques such as colour coding to record 'everyday' and 'mathematical' definitions.

Learner acquisition of new vocabulary can also be assisted by the provision of scaffolding within teacher talk. For example, using a specialist term in context and alongside an explicit reference to meaning may be helpful. If a teacher were to ask 'How many horizontal lines can you see in this picture?', it may be useful to include additional scaffolding within the question: 'How many horizontal lines—lines that go across the page—can you see in this picture?'. Gestures accompanying the description of 'across the page' and visual reminders may also assist the learner to decode this word in order to perform the mathematical operation required to answer the question.

Importantly, classroom communication about abstract mathematical concepts provides a forum for learners to 'think aloud', verbalise their cognitive processes, share hypotheses, justify the use of particular mathematical operations and review outcomes. Meaningful classroom conversations are also important opportunities for learners:

> to extend their thinking and knowledge to encompass other perspectives and experiences, to understand their own problem-solving and thinking processes as well as those of others, and to develop flexibility in representing and interpreting ideas (Martinez & Martinez, 2001: 5).

However, depending on their proficiency in the language of instruction/classroom communication, learners with an EAL/D background may find classroom talk difficult to navigate both in terms of speaking and listening. Educators can assist by providing ample ‘wait time’ for learners to think about questions and formulate their responses, encouraging students to explain their answers and thought processes, and utilising visual representations of knowledge to accompany verbal explanations. Providing a pre-speaking planning task which includes a review of relevant language may also bolster learner confidence and sense of readiness to participate in classroom conversations.

There is a significant body of research regarding code switching, code mixing and language switching in the mathematics classroom (Moschkovich, 2002, 2007; Roberts, 1998). This is a complex, multifaceted topic, with a range of important social, cultural and political implications. Factors that impact a learner’s use of particular languages and/or dialects in the classroom may include individual preferences and learning style, the language background of interlocutors, the task or purpose of the communication, and a range of other situational variables such as the classroom and institutional culture (Moschkovich, 2007).

It is important for educators to be aware of the diversity of ways for ‘making meaning’ in mathematics and the role of language and culture in shaping these practices (Barwell, 2016). Acknowledging that there are many ways to conceptualise and communicate mathematical notions provides an important opportunity for learners to share their own cultural and linguistic knowledge and engage with new ways of seeing the world. This also provides opportunities for learners to describe mathematical concepts for which there may not be English terms, but which are essential to their own numerate understandings. Research suggests that, when implemented appropriately, community partnerships with schools can also enrich classroom learning for all students by facilitating the exchange of mathematical ideas, knowledge, dispositions and social practices from a range of cultural and linguistic perspectives (Barwell, 2002; Howard, Feirer, Lowe, Ziems, & Anderson, 2006; Howard, Perry, Lowe, Ziems, & McKnight, 2003).

What does this mean to you as a teacher of numeracy?

- It is important to provide frequent opportunities for learners to use specialist language in varied and meaningful ways
- Providing additional scaffolding through teacher talk, the use of realia and props and vocabulary journals may be useful
- School–community partnerships can facilitate greater exploration of the languages and cultures of mathematics.

Schleppegrell (2007: 141) has identified the importance of symbolic notation within the discipline of mathematics commenting: ‘mathematics symbolism has developed to express meanings that go beyond what ordinary language can express’. Acquisition of mathematical symbols requires visual literacy, defined by

Wileman (1993, p. 114) as ‘the ability to “read”, interpret, and understand information presented in pictorial or graphic images’. Learners require both knowledge of the concepts represented by the symbols and the ability to read these symbols in context.

To complicate the process of acquisition, there are many mathematical symbols that look alike, such as the division and square root signs (Kenney, 2005). Further, unlike some words, symbolic representation offers no clue as to pronunciation (Barton and Heidema, 2002). For example, there is nothing inherent to the symbol ‘<’ to assist the student with its pronunciation. As Barton and Heidema (2002: 15) assert,

> In reading mathematics text one must decode and comprehend not only words, but also signs and symbols, which involve different skills. Decoding words entails connecting sounds to the alphabetic symbols, or letters…. In contrast, mathematics signs and symbols may be pictorial, or they may refer to an operation, or to an expression. Consequently, students need to learn the meaning of each symbol much like they learn “sight” words in the English language. In addition they need to connect each symbol, the idea it represents, and the written or spoken term that corresponds to the idea.

Further, just as certain words have a range of meanings, many symbolic forms of representation have multiple uses. For example, the circle to express the degree of an angle (e.g. 90°) is also used when expressing the degree of temperature (e.g. ‘30 °C’) (NALDIC, 2002). In order to be ‘code breakers’ (Freebody & Luke, 1990; Watson, 2014), learners must be able to ‘read’ these symbols and understand their use in context, as they would read a text containing words.

Variation of numerical symbols across linguistic contexts may also cause confusion for some learners (Ciancone, 1996). A key example of such variation occurs in relation to the use of commas and decimal points as delimiters when writing numbers (Ciancone, 1996). English-speaking countries generally employ a comma, e.g. ‘5,678.00’, whilst some European countries use a decimal point or space, e.g. ‘5.678,00’ or ‘5 678,00’. This can create additional confusion for learners who may be familiar with a different system of representation.

In the same way that mathematical words require attention to pronunciation, meaning and use in context, it is important to provide plenty of opportunities for learners to work with the various symbols of mathematics. Activities that require learners to match symbols to their definitions and/or associated word can provide exposure to symbolic, written and aural language. Such activities can be relatively simple, such as a game of ‘bingo’ with the teacher or a class member calling out the symbols, or ‘fishing’ where learners are allocated a particular mathematical symbol and then required to ‘catch’ a magnetised flashcard with the corresponding word or picture of the concept using a ruler and string with a magnet on the end. Jumbled sentences, where learners have the opportunity to speculate on the order of symbols and words and the impact on meaning, can also be a useful technique for assisting with the acquisition of symbols.

Matthews et al. (2007: 249) have worked with learners using narratives to compose their own algebraic symbols, employing ‘a Maths as Story Telling (MAST) teaching approach’. The authors explain

> Our answer to the dilemma of contextualising the teaching and learning of algebra was to focus on representing mathematical equations as stories which leads to contextualising of mathematical symbols. Thus, we developed an approach to symbolisation based on students creating and using their own symbols, drawn from their socio-cultural background, to describe these stories as a precursor to working with the accepted mathematics symbols (Matthews et al., 2007: 251).

Visual literacy skills are also required for students to access graphical representations of data (Quinnell, 2014). Charts, graphs and tables play an important role in mathematics. Yet, frequently these text types are not addressed as specific genres with particular features, structural stages and purposes. Visually literate learners understand that, just as a written text type such as a narrative or a procedural text has a particular structure and stylistic features, visual text types contain certain characteristics and structures.

It is important to facilitate guided deconstruction of the particular features and stages of visual text types in mathematics, as well as providing activities where learners can match values with graph axes, complete ‘skeleton texts’ where various components are omitted and finally, develop their own visual representations of data (Quinnell 2014: 16). It is also essential to encourage learners to take a critical view of graphical representations of data in order to ‘identify possibly misleading elements or factors which contribute to biased messages being given’ (Quinnell 2014: 16).

What does this mean to you as a teacher of numeracy?

- Symbols are an important system for making meaning in mathematics (Schleppegrell, 2007) and learners are required to acquire knowledge of symbols, an understanding of the concept they represent and how they are pronounced and written.
- Visual text types such as charts and graphs also need to be deconstructed with learners in order to apprentice them into these ways of making meaning (Quinnell, 2014).

Grammatical Forms of Mathematical Language

As with all disciplines, mathematics uses particular grammatical forms to convey and create meaning. Schleppegrell (2007: 143) notes ‘Teachers typically recognise the technical vocabulary as a challenge, but may not be aware of the grammatical patterning that technical vocabulary brings with it’. Mathematical language favours the passive form, evident in the sentence ‘ten divided by three’. This form is common across a range of academic disciplines but may present particular issues for EAL/D learners from a variety of language backgrounds (Hinkel, 2002).

Activities that draw attention to syntax can be useful in assisting learners to work with the passive form. For example, breaking up sentences into individual components and having learners peg each word or symbol onto a 'mathematics clothes line' will reinforce both the mathematical concept and the syntactical knowledge involved.[3] Activities that require learners to modify active sentences to the passive form can also be fun and engaging. For example, learners may be given a sentence expressing a mathematical problem in the passive form and be instructed to find their classmate who has the equivalent sentence in the active form. Once learners find their partner, they can work together to solve the problem. The sentences can increase in syntactical and conceptual complexity as the learners' knowledge and skills increase.

In addition to the passive form, a range of complex clauses are utilised to express mathematical relationships, including comparatives such as '*greater than* ten' or '*equal to* the largest amount'; conditionals such as '*if* I have ten apples and drop five, how many apples will I have?'; conjunctions such as 'four *and* two'; and connective adverbs such as 'Add five *then* subtract three'. A simple activity where the learners examine and discuss three-dimensional models of different shapes in order to make comparisons with other shapes in the classroom and at home requires complex grammar. Learners require both specialist terminology for the names of different shapes, but also comparatives, for example, adding the suffix '-er' to one or two—syllable adjectives ('smaller', 'rounder')—using 'more' for adjectives with three or more syllables ('This shape is more interesting'), and the irregular comparative adjectives (such as 'better') (ACARA, 2014a, 2014b). Explicit attention to grammatical patterns, encouraging learners to use their problem-solving skills to speculate as to why we may say 'smaller' but not 'beautifuller', can be helpful.[4] Counting the syllables in each word and speculating on the grammatical pattern can assist learners to become proficient in the language of mathematics while using mathematical operations as learning tools.

Another key element of the language of mathematics is the 'word problem', which is a specific genre, involving particular grammatical forms and assumptions for engaging with the text (Watson, 2014). As Barwell (2011: 1) suggests 'Simply decoding words or extracting arithmetic operations is not enough: students must learn to read between the lines and understand what they are expected to do mathematically'. Research has shown that some learners systematically underperform in solving word problems, often because they treat the problems too literally (Tomlin, 2002). Whilst the abstraction common to the mathematics discipline renders the subject challenging for many learners, the provision of a context—if unscaffolded—may create other issues.

In order to provide assistance with word problems, Barwell (2011: 2) suggests teachers consider how learners approach the task of writing their own problems as this 'gives some insight into what features they are aware of, not just as a mathematical task, but also as a form of text'. In order to deconstruct the textual features

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[3]Acknowledgement to Dr. Maura Sellars for this idea.

[4]It is also important to acknowledge that different dialects of English incorporate different grammatical patterns.

of the word problem, Barwell (2011) suggests encouraging learners to compare two different scenarios that require the same mathematical operation. This may help to illustrate the irrelevant nature of some details in the scenarios. Encouraging learners to rewrite existing problems to make them more relevant to their own social and cultural contexts can also promote greater engagement with both the relevant mathematical content and the genre of word problems.

This notion of connecting mathematics instruction to the learners' social and cultural contexts is important. The 8way maths website, a teacher guide to the 8 Ways Aboriginal Pedagogy Processes framework, advises 'Rather than trying to bring out the culture in maths, we need to bring out the maths in culture'. This teacher resource further recommends that educators

> Relate problems and maths applications back to community life wherever possible. Where a community equivalent does not exist for content you are teaching, discuss ways in which the new knowledge could be applied for community benefit. Create outlets and projects for students to teach/apply important mathematical knowledge to the community (8way maths, n.d, n.p).

In contrast to hypothetical scenarios or decontextualized word problems, the application of mathematical concepts to authentic situations has the potential to enrich and extend mathematical education. This is not to suggest that teachers should not actively deconstruct and explore the genre of word problems in mathematics education, since this is a key question type featured in many standardised and high-stakes assessments. Rather, linking mathematical concepts to real-world applications provides an important, meaningful augmentation to traditional mathematics questions and helps learners' to see that all mathematical texts function within social and cultural contexts (Barwell, 2011).

What does this mean to you as a teacher of numeracy?

- There are particular grammatical forms that characterise mathematical communication;
- Building on learners' understanding of syntax through activities such as jumbled sentences and changing active to passive forms can be useful ways to explore these grammatical features;
- The mathematical word problem is a specific genre that employs complex and/or less common grammatical forms and particular expectations for 'reading between the lines' (Barwell, 2011);
- Working with students to deconstruct the genre of the mathematical word problem and to rewrite problems according to learners' experiences can be a helpful way of connecting mathematical concepts to real-life contexts (Barwell, 2011).

Cultural Knowledge in Mathematics

As Street (2003: 84) advises, ‘Numeracy even more than literacy has been seen as a “universal”, “context free” set of skills that can be imparted across the board, irrespective of children’s background experiences and prior cultural knowledge’. Yet, such a view fails to recognise the social nature of mathematical practices and, as Street (2003: 84) asserts, is ‘inappropriate especially in the multilingual, multicultural situations that characterize contemporary hybrid cultural contexts’. Research in the areas of ethnomathematics, mathematical history and critical numeracy has increased awareness of mathematics as ‘an ongoing creative and cultural (indeed, multicultural) process rather than a received fixed set of rules and abstractions’ (Lesser & Blake, 2007: 351).

Engagement with mathematical texts in the primary classroom often requires an understanding of specific cultural and social contexts (Watson, 2014). The exploration of mathematics as an important form of social practice provides enormous potential for deep, substantive learning, although care must be taken to avoid oversimplification or token attention to ‘cultural content’ (Brandt & Chernoff, 2014; Wiest, 2002). Authentic and rigorous engagement with varied cultural understandings of mathematical concepts, such as counting systems, ideologies of ownership, norms for predicting and classifying, and attitudes to luck and chance, provides an important opportunity for all learners to explore these concepts from a range of social and cultural perspectives and to expand their ability to think creatively and analytically. Consultation with members of the community can ensure such attention to cultural aspects of mathematics occurs in appropriate, respectful and authentic ways.

Cultural variations occur not only in the linguistic expression of time, measurement and other mathematical concepts, but also in terms of the conceptual understandings themselves. Languages represent mathematical concepts in different ways and some mathematical terms will not have a clear translation across languages. For instance, in Chinese there are individual characters to represent the numbers zero to nine. Accordingly, the number nineteen is represented as base ten plus nine rather than using a new word such as in English, i.e. ‘nineteen’. Likewise, expressions of time vary across cultures, with some languages expressing 12.45 pm as ‘a quarter to one’ whilst others referring to ‘one minus a quarter’. Cultural variations also occur in the conceptualization of mathematical notions such as time. The Board of Studies, Teaching, and Educational Standards (BOSTES) (n.d, n.p) NSW advises

> Mathematics is a representation of the world that has developed over thousands of years through many diverse cultural contexts. Aboriginal and Torres Strait Islander cultures have a rich understanding of mathematics that includes a broad range of applications of mathematical concepts…The NSW K–10 Mathematics curriculum values Aboriginal and Torres Strait Islander perspectives of mathematics and provides opportunities for students to investigate various aspects of number, measurement and geometry, including time and location and relevant interrelationships, in Aboriginal and Torres Strait Islander contexts.

Professional resources, such as the 8way maths website, provide useful information regarding teaching options and approaches to maximise exploration of social and cultural 'meaning making' within mathematics education. The Queensland Studies Authority (2013) provides links to a range of teaching resources and learning frameworks designed by community members, teachers and researchers. These resources are presented according to the three content strands of the mathematics curriculum: 'number and algebra', 'measurement and geometry' and 'statistics and probability' (ACARA, 2011).

A link to a 2010 study conducted by the Australian Council for Education Research exploring learners' use of spatial strategies in an addition task is also included on the Queensland Studies Authority website (2013). The study explored the different cognitive skills and spatial strategies used by speakers of English and speakers of Warlpiri and Anindilyakwa, languages from the Northern Territory in which counting words are not available. The study found that the Warlpiri and Anindilyakwa speakers had extensive spatial strategies and employed these cognitive abilities more frequently to solve the mathematics problems than the English-speaking learners, who relied more on enumeration strategies supported by counting words. Such studies reinforce the need for educators to acknowledge and accept diverse approaches to 'meaning making' and problem-solving in mathematics.

Ciancone (1996: 3) advises encouraging learners to consider many different approaches to mathematical problem-solving, suggesting 'it is usually best to observe how learners approach problems and then to build on that'. This fits with the additive bilingualism approach (Cummins, 1984) that considers learners' linguistic and cultural repertoires as valuable assets to their own and their peers' education. The 8way maths (n.d, n.p) website asserts

> While we are questioning the accepted orthodoxies on cultural inclusion, we may as well also be questioning the orthodoxies of maths teaching. For example, it is widely accepted that the process of learning maths is vertical, meaning you have to learn "a" before you can understand "b" and so on. Is this really true, or is it possible for maths to be approached as a non-sequential, integrated, connected, learner-directed body of knowledge explored through authentic projects and tasks?

What does this mean to you as a teacher of numeracy?

- Different languages represent mathematical concepts in particular ways and some mathematical terms will not have a clear translation across languages;
- Variations in cultural understandings of mathematical concepts such as time or probability provide an important opportunity for all learners to consider mathematics from a range of social and cultural perspectives (Brandt & Chernoff, 2014).

Conclusion: Scaffolding Learner Engagement with Mathematics

All learners in the mathematics classroom are challenged to navigate both the underlying concepts and the language required to engage with such concepts. Accordingly, mathematics instruction is also language instruction. Ensuring a language-rich learning environment may greatly enhance learner engagement with the skills, knowledge and dispositions required for mathematical practices. As Barwell (2008: 4) asserts, ‘If children are to learn mathematics, there needs to be a focus on mathematical meaning-making’.

As emphasised in this chapter, there is no one optimal form of instruction for all learners. Accordingly, teachers need to invest time and seek assistance when determining the strategies best suited to individual learner needs. Reflecting on the various linguistic and cultural requirements for engagement with mathematics can assist teachers to plan for scaffolding learner participation.

Providing opportunities to participate in the language of the mathematics classroom using a range of modalities, such as visual and kinesthetic approaches, may be helpful (Barwell et al., 2002; Cunningham & Allington, 1994). Real-world application of numerical concepts may also assist learners to make connections with mathematics and ensure that instruction reflects a range of cultural and linguistic contexts (Barwell, 2011; Ciancone, 1996). The more learners communicate about mathematics the more they

> begin to see mathematics, not as an isolated school subject, but as a life subject—an integral part of the greater world, with connections to concepts and knowledge encountered across the curriculum (Martinez & Martinez, 2001: 5).

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Part II
Introduction to Section Two: Planning to Support Numeracy Competencies

This part is designed to illustrate the importance of numeracy across the curriculum. Each chapter contains a theoretical introduction to the discipline area and several lesson samples that demonstrate the embedded numeracy in the task and also the ways in which the discipline can support the development of mathematical concepts and provide students with opportunities to learn mathematics through the numeracy that is required to successfully complete tasks across the curriculum. The lesson that are presented are not developed to be exemplars of 'best practice'. This is because the term 'best practice' begs the questions—'Best practice for what outcome or end?' and 'best practice for whom?' These lessons are suggestions for starting points only and, as such, necessitate sensitive differentiation and accommodation to authentically bridge the gap between teaching and learning for all students in any one learning context. In order to do this, the lessons are accompanied by a left-hand 'perspectives' page which contains prompts for consideration and critical reflection in relation to the students in any classroom cohort. These perspectives include the following:

The Learning Task

This information identifies the focus of the lesson and the suggested age group for whom this lesson is developed. It may also include additional information that indicate the conceptual and practical skills which are the aims of the lessons.

Numeracy Links

Although each lesson contains numerous opportunities for students to apply what they know and what they learned in mathematics at school, only some numeracy concepts that are basic to the completion of the tasks are indicated. That is not to say that teachers and student teachers should not or will not identify and pursue other numeracy concepts in the tasks. In order to support teacher and student teachers' identification of the embedded numeracy, asterisks have been used to indicate which outcomes and descriptors from the Australian Curriculum Mathematics best identify the mathematical knowledge skills and concepts that are integral components of the task. The asterisks are placed at moments in the lesson tasks where teachers may choose to make links to mathematical learning or to prompt students to identify where and when they have interacted with the embedded numeracy skills in the contexts. Exactly how and when these links are forged is determined by the teacher, bearing in the mind their own context, scope and sequence, and students' relative strengths and limitations in mathematics. Awareness of the potential of the essential nature of the numeracy in other key learning areas may impact positively and authentically on the students' attitudes towards mathematics learning and enable them to recognize the mathematics in their out of school activities as important and necessary.

To expand the numeracy links embedded in any lesson, it is useful to think critically about the actual components of the tasks. For example, the numeracy links in the Media lesson for Year 2 are focused on the concepts and language of chance. However, it could just as easily be used to discuss the concepts of sequence, ordering, time, proportion, operations and measurement. Does the order of the activities mentioned in each year really matter? Why is the chronology important? How long is a year in months, seasons and weeks? Are some activities more appropriate towards the end, beginning or middle of the year? What are ordinal numbers and what do they tell us? Why would the story strip have sections that are all of the same size? Are all years approximately the same length? What is a leap year and when do they happen? What would the story strip look like if some years were represented by long spaces on the strip and others were much smaller? Why is formal measurement useful? How do you use a junior ruler correctly? What are the calibrations and what might the ruler be divided up like this for measuring in centimeters? Can you share your strip of paper easily into the number of years you will be on your next birthday? How can you do this using a ruler? Are the students using additive or multiplicative thinking to work out how to share their strip into the required number of years? The potential is almost limitless but it is important also to see that these mathematical skills used as numeracy competencies are an embedded part of the media task and that the integrity of the media learning is preserved and promoted whilst making these numeracy links.

Including Aboriginal and Torres Strait Islander Perspectives (ATSI)

It is acknowledged that the terminology around referring to the original custodians of the land is contested and there is a range of important issues associated with this. In this text, ATSI is respectfully used as the acronym for the term 'Aboriginal and Torres Strait Islander' to refer to original peoples of the area now referred to as Australia and Torres Strait Islands. The perspectives of these diverse peoples are important inclusions in every lesson in Australian schools. The means by which this achieved must be to enhance inclusion and social equity and not to further isolate or marginalize these students. Activities included in this part are intended for whole class engagement, using suitable pedagogical strategies and, where appropriate, seeking advice from community members and parents. It is important to note that many of the strategies nominated as supporting the learning of ATSI students are, in fact, extremely well suited to the support the learning of a wide diversity of students who are not included in these groups.

Variations for Students of Diverse Backgrounds

The impact of globalization, international conflict and unrest, the increase in geographic mobility, the promotion of English as the international language and the educational policies of inclusion relating to students with 'special needs' have all contributed to the diverse nature of the backgrounds of students in Australian classrooms. As all students have the right to educational opportunities that support their learning, an important consideration for teachers is how best accommodate and promote the best learning environment for students whose communities may have different customs and traditions with regard to perspectives, values, interpretations and interaction around childhood, education, relationships and even the use of the English language. Additionally, students who are considered to have physical, mental or academic disadvantages or disorders may require that their teachers reflect on the types of experiences upon which their further learning depends. Categorizing, stereotyping or pathologizing students with reference their cultural, social or personal backgrounds is not only unprofessional, but it has the potential to widen the gap between teaching and learning in many classrooms.

Authentic Assessment Strategies

These ideas or recommendations usually reflect the outcomes and all the elaborations that have been taught through the lesson(s). It is not acceptable to attempt to assess student progress on aspect of the outcome(s) that were not part of the lesson. It is also counterproductive for the learning of all students to assess the entire cohort on the participation of a few students in a class discussion, to expect a piece of written work to be the determining product for all types of learning tasks and activities or to assess a group activity or task on the basis of the work produced by one or two students in the group. Assessment has three major types: (i) observation (Can the students actually do the task competently? What happens when…? etc.), (ii) sustained academic conversation where teacher and student individually discuss work together with the teacher asking supportive questions (not the question—response—yes or no type of triadic questioning) and (iii) product analysis, where the product can be literally any product that is the result of engagement with the task (written, performance, model, painting, drawing, music, song, etc.). All assessment at present is benchmarked to the Australian Curriculum outcomes and elaborations (or the state or territory equivalent) and recorded in levels of competency using the national reporting coding and evidence-based criteria.

Including Students with Backgrounds of Oracy

For many teachers, it may be difficult to imagine a life totally without print materials because it is so much a part of the world in which it works. However, as many children with refugee experiences are now students in Australian schools, the important role of supporting all learners is a considerable challenge for teachers in various parts of Australia. Many of the students with backgrounds of oracy are of African origin, such as the students from Southern Sudan who have been arriving in Australia for more than a dozen years. Many of the examples that are given in this perspective are examples of the knowledge gained from the so-called 'Dinka' people from Southern Sudan, who, like many other African peoples, have a rich cultural background based on the spoken word. Students from backgrounds of oracy have highly developed cognitive capacities for learning and memorizing from interactive narration. The storyteller (teacher) uses rhetoric, gesture, movement and repetition to engage the audience (students), who are actively involved in the process using bodily kinaesthetic actions and responses. Unfortunately, in many classrooms, these students are frequently considered to be poor learners due to their lack of print knowledge. To include these students authentically and respectfully, it is important to focus on their cognitive strengths, not on their deficits, and to incorporate pedagogical strategies that offer them socially just and appropriate learning opportunities. It is also important to remember that, even if these students are born in Australia, all the learning they do is not at school and learning at home and in the community may reflect more traditional ways of knowing. Included in this perspective are students from print background who have little or no knowledge of print apart from the repetitive following of text from religious books and those who have had interrupted schooling and little or no opportunity to have contact with print materials. For students to be included in class activities and communities and not further marginalized, all students in the class should have opportunities to engage with the strategies that facilitate learning for this group of students. This will support all students' development of inter-cultural knowledge and provide them with skills in alternative ways of knowing and making meaning.

Australian Curriculum Outcomes and Elaborations

The subject outcomes and elaborations from the Australian Curriculum that are the focus of the lesson are listed here.

Differentiation

These perspectives indicate just *some* of the ways in which the task can be altered, added to or modified to facilitate further learning. Some authors have determined these as additional activities after the main tasks have been achieved, but lessons can certainly be started from different points depending on the capacities of students. The three major ways in which differentiation can occur are (i) content, (ii) pedagogical strategies and (iii) environment. For detailed information about each of these methods of differentiating tasks to promote optimal student participation, engagement and success, see Sellars, M. (2014) *Reflective Practice for Teachers*, Chap. 11.

Australian Curriculum: Mathematics

This part indicates the *selected* mathematics outcomes and elaboration that have been embedded in the lesson task(s) or are the result of mathematics learning using another discipline as focus of the learning. These cells may not include all of the associated mathematics outcomes and elaborations, and teachers are able to add to these and include in assessment where appropriate.

Dance

Gavin Beck and Maura Sellars

Introduction

An equitable curriculum is one that acknowledges the natural mind–body relationship, which characterises how human beings think and operate in the world (Henriksen et al. 2015). It involves embodied learning and thinking strategies that place the physical body back into education, through carefully designed learning experiences that allow knowledge a place to be stored, a place to be extracted from, and a place to be exhibited through (Barbour and Ebrary Academic Complete International Subscription Collection 2011). To participate fully in activities that promote these actives and provide these learning opportunities, students need to engage with several mathematical concepts. Irrespective of the diversity and difference found in student cohorts, the benefits of dance and movement, and the potential for creativity, experiencing dance is not possible without the embedded mathematics that can be identified as numeracy competencies.

Dance integrated pedagogy supports students with special needs and empowers bodily-kinaesthetic learners (Gardner 2011). It has the potential to provide creative learning environments that encourage multiple ways of knowing (Cone and Cone 2012), while at the same time, fosters social bonds and develops student empathy through shared learning experiences (Roy et al. 2012). Dance integration has the potential to reach students who struggle with traditional ways of learning mathematics by providing embodied, playful, creative, and artistic means of expressing and developing their understandings of numeracy. Dance integration does not undermine or replace the existing dance capabilities students develop in both

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creative arts and physical education. It provides an embodied way of knowing that has the 'capacity to connect body, mind, heart, soul and imaginative thinking', and ways of presenting questions 'when we ask them through our bodies' (Ace Staff and Ebrary Academic Complete International Subscription Collection 2012: 55–57).

The mathematical teaching and learning experiences embedded within dance education are engaged in new ways than when integrated with other learning areas. Embodied learning strategies value the relationship students have with their bodies, the physicality of their peers and teacher, and the physical learning environment (Yoo and Loch 2016). Teachers must value students' ways of knowing, such as playing an instrument, feeling the rough texture of a palm leaf or the weight of gravity when jumping in the air, to provide learning that is 'constructed or created rather than existing as independent truths out there in the world' (Barbour and Ebrary Academic Complete International Subscription Collection 2011: 95).

> The embodiment of human meaning and understanding manifests
> itself over and over, in ways intimately connected to forms of imaginative
> structuring of experience… (This) does not involve romantic
> flights of fancy unfettered by, and transcending, our bodies;
> rather, they are forms of imagination that grow out of bodily
> experience, as it contributes to our understanding and guides
> our reasoning (Henriksen et al. 2015: 7).

By engaging with the pedagogies, skills, and concepts of Dance education in other learning areas, teachers are able to facilitate embodied learning experiences using integrated pedagogy that empower both learning areas, without one being a servant to the other. A lesson on two-dimensional shapes in mathematics, for example, could involve students exploring locomotor movements to embody the shape of a square, circle or triangle, or students could improvise body profiles that represent these shapes, or both ideas could be combined to produce a dance work using two-dimensional and three-dimensional space as stimulus in a student-centred learning environment.

The focus is on equity by employing movement and dance experiences as an alternate way of understanding and exploring numeracy, and has the potential to empower students who do not relate or connect with the traditional textbook approach to teaching mathematics (Palmer 2010). Dance integration provides learning experiences that are inclusive and allow access to new ways of engaging with student learning and understanding, by examining concepts from other key learning areas in a new light. Developing high levels of competency in mathematics can be common hurdles for a wide range of students, including students who are perceived to lack the rational, objective, and logical ways of thinking, which are traditionally associated with high outcomes in mathematics (Palmer 2010). Dance integration provides new approaches to numeracy that allow students to express their understanding through embodied ways of knowing and inherently provide creative thinking through the design of dance choreography with explicit Maths outcomes.

Examples of mathematics integrated into dance lessons as numeracy competencies would be lessons involve students representing fractions through whole, half or quarter turns when moving through space, creating symmetrical and/or asymmetrical shapes using body actions, or by providing opportunities for students to count number names and numerals when performing actions to a set number of beats. For example, extending arms outward while counting from 1 to 4 and then back again for counts 5 to 8 forms a sum of 8 beats for the entire movement sequence, which also requires understandings of space, position, and pattern.

Dance and Mathematics

An analysis of the Australian Curriculum: Dance indicates that from the very first school-based experiences of dance, students are required to engage with mathematical constructs. They are required to incorporate notions of sequence, pattern, and relationships into their dance activities. The outcomes and descriptors for foundation to year two students also require that consciously make decisions about position, spatial understandings, and different types of travelling and movement that are integral to the mathematics learning across these age groups. The rich contexts and components of dance at this level also involve children in the considerations of two-dimensional shape and three-dimensional objects and how the properties of these may be imitated, independently or in collaboration with others. The students also need the mathematical knowledge to understand complex mathematical notion in context, such as duration, elapsed time, and timing.

In similar fashion to the mathematics curriculum, students are asked to describe dance sequences, which necessitates not only dance metalanguage but also the language of mathematics to fully illustrate their understanding of the conceptual notions of sequence, establishing the importance of mathematical language in dance, in addition to commonly found language which acquires specific meaning when used in the contexts of mathematics and numeracy. In fact, the elaboration of the outcome (ACADAM001) is a prime example of how not only mathematical concepts, but also mathematical vocabulary, mirror much of the rhetoric found in the Australian Curriculum—Mathematics for the same cohorts of students;

> experimenting with the elements of space, time, dynamics and relationships
>
> through movement, for example, considering levels, tempo and dynamics

The following stage builds on these skills that form the numeracy foundations of dance and incorporate more complex understandings of these mathematical actions. For example, students incorporate knowledge of direction as an aspect of position, increasing and decreasing (growing patterns and scale) the size of movements, specific steps or sequences, repeating patterns and variations are also incorporated into dance activities during these learning activities for years three and four. There is an emphasis on space, utilising the students' understandings two and three dimensionalities, relative position in higher, lower, etc., position, direction, and angles. The process strands of mathematics are also explored further as students engage in reasoning, communicating and problem-solving in the contexts of creating, adapting, and designing further variation to dance sequences learned. Students also engage with historical time, reasoning with reflection and determining logically the purpose of culturally diverse, traditional, and specific dance traditions.

The curriculum designed for years five and six is no less complex and mathematically orientated. Students are required to work with mathematical content and concepts to such as number, shape, grouping, position, and space to represent ideas, perspectives, and feelings. They are introduced to the development of increasing complex irregular shapes and bodily positions to demonstrate dance technique and interpretation. Students must demonstrate complicated combinations of angles individually and in relation to the positions and dance techniques of others, and engage with symmetry and its various types of transformations, all of which mirrors the learning in the mathematics curriculum, specifically in the content areas relating to space. Additionally, there are aspects of number which are always in place in the development of sequence, formations, and parts of formation, partitioning and fractional use of continuous area in addition to the discrete quantity that is the beginning or concluding number of the formations. Whilst dance is more than mathematical activity performed as numeracy capacities, it cannot be engaged with at any level without understanding the embedded mathematics in action.

Conclusion

While many educators undervalue Arts in the curriculum and dance in particular, there is a growing branch of inquiry that demonstrates the importance of Arts integrated learning across the curriculum (MCEETYA and CMC 2005), especially as a nonverbal form of communication and expression. A longitudinal study conducted by Nichols and Stephens (2013) found that students who participated in Arts-rich curriculum were more engaged in their learning and the wider school community than students from schools that either marginalised the Arts, or failed to provide quality Arts education in their curriculum. In due course, neuroscientists, who argue the benefits of dance for increased intellectual capacity (Hanna 2015; Brown and Parsons 2008; Dale et al. 2007), may provide the educational community with sufficient evidence to mandate the inclusion of dance as a high priority subject that requires everyday engagement! Integrating dance with other learning areas has proven to aid student confidence, enhance their motivation to learn, improve social bonds and acceptance of others, all of which is vital to students' successful engagement with 'academic' subjects such as mathematics.

When successfully implemented, dance integration has the potential to increase student attendance rates, academic success, and student well-being, by developing life skills, creativity, and self-expression (MCEETYA and CMC 2005). Dance provides social justice in education for all students, including bodily-kinaesthetic learners and students with special needs as they have access to numeracy in ways other than provided by traditional mathematics pedagogies. It develops students' critical and creative thinking skills, which are an important outcome of twenty-first century education and allows students to look at mathematics, in the dance context of embedded numeracy, from new perspectives and experiences. Engaging with the mathematics which provide the foundations of dance education as numeracy competencies not only provides a more holistic understanding of the mathematical content and concept(s) being investigated, but prompts the hypothesis that only mathematicians can truly understand the complexity and components of dance.

Differentiation: This lesson structure can be applied to any type of narrative that the students suggest and enjoy. There is a differentiated task at the end of the lesson which provides for student creativity and alteration or accommodation to the task. Students who are not ambulatory can be helped with the arm movements and similar adaptions made for any number of student contexts

Australian Curriculum Mathematics Outcomes and elaborations:

*ACMMG010

Numeracy Links:

*Describe position and movement. Interpreting the everyday language of location and direction, such as 'between', 'near', 'next to', 'forward', 'toward'

Australian Curriculum Subject outcomes and elaborations: Explore, improvise and organise ideas to make dance sequences using the elements of dance (ACADAM001).exploring fundamental movements safely to improvise dance ideas, for example, running in a race, jumping like a frog, stomping like a giant, rolling like a log, falling like an autumn leaf, floating like a cloud, gliding like a bird.

The Learning Task: Dance: Foundation—Kangaroo Dance

This task is supported by video and narrative. It is a suitable task for most students but may require spots uniforms to be won and to be implemented on carpet.

It combines, dance as narrative with the language of position and movement.

Including ATSI perspectives: This task is focussed on exploring the activities in the natural environment by using dance. It is particularly well suited to these students as storytelling through dance is part of their traditional culture and heritage and is a culturally appropriate way of knowing and passing on knowledge. The class may wish to explore traditional dances.

Strategies to include learners with oral backgrounds: This activity is a particularly useful approach to use for these students. Many complex cognitive capacities have been developed specifically by those with an oracy tradition. These rely heavily on performance participation, movement and action and conceptual understandings expressed as dance. This activity really needs no language and students can adapt this notion to express any number of ideas, information and narratives without the use of language.

Authentic Assessment strategies:
Observation:
Were students able to hop using light and springy locomotor movements and maintain good balance?
Were students able to perform movements with accurate attention to the size, force, shape and height in response to the text?
Were students able to perform the movements of the dance in the form of the narrative?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally ion classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

Dance: Foundation—Kangaroo Dance

Resources MP3 or CD player, traditional Aboriginal music or environmental sounds of Australian bushland, https://www.youtube.com/watch?v=74cbz3wR65A, https://www.youtube.com/watch?v=2qBgMmRMpOo.

Children dance to a narrative about difference and acceptance
Pretend we are a baby kangaroo exploring the world. What does a kangaroo look like? Focus students' attention on its long tail, large springy legs, small arms, and movement (hopping). Play the short video of a kangaroo moving in nature and a joey in a mother's pouch to engage students. Students will perform their movements following the form of a narrative (movements are underlined in the text). **Warm-up**: Students copy teacher performing a variety of non-locomotor movements discussed in the narrative. For example, small, gentle climbing/clawing arm movements; or curved, flowing, and stretched body shapes that imitate the movement of a kangaroos' tail; or large and slow movements or stills in imitation of looking around, or listening. For example, 'Joey heard a howl'. Students explore locomotor movement by hopping around the room using light, springy movements. Encourage students to explore straight and curved pathways.

Detailed organisation and implementation
Teacher reads story below aloud to students, stopping when required to demonstrate the movements that students copy. Allow students time to perform their movements in response to the text. Make sure to focus and support students, when performing the dance, by demonstrating large and small movements where required, the use of soft or strong energy (for example, the strong, stalking movement of the dingo, or the light springy movement when hopping around the performance space), and the extended, curved movements in imitation of Joey's tail*.

> Joey is a small kangaroo who lives in the safety of his mother's pouch. During the day, he <u>curls up into a small ball and sleeps</u>. Although Joey loved his mother and enjoyed living in her pouch, he was curious about the world outside his home. One day, <u>Joey heard a howl in the bush near his home</u>. He wondered what animal made such a strange sound. <u>He slowly and gently climbed out of his mother's pouch, using his tail, springy long legs and short arms to leave</u>. <u>Joey hopped forward for four counts</u> (hop, hop, hop, hop), <u>looked slowly around</u>, <u>bent low to smell and claw the ground</u>, <u>then hopped in a different direct, for four more counts</u> (hop, hop, hop, hop). Suddenly a dingo came running toward him, then stopped and said hello. <u>Joey waved to the dingo first with his small arms, then he wiggled his long tail, and then jumped in the air while turning around in excitement</u>. The dingo thought Joey was funny, because he hopped everywhere he went, and asked him if he could walk on all fours like a dingo. Surely, the dingo said, this is the correct way to move around? <u>Joey tried to walk on all fours like a dingo, moving with strong, flowing movements.</u> But this didn't feel right for Joey, because he was a kangaroo not a dingo, so <u>he slowly stood up straight on his long springy legs, and hopped back home for 8 counts</u> (hop, hop, hop, hop, hop, hop, hop, hop).

Differentiation: This task can be implemented in any number of contexts that include opportunities for the students to hold 'still' while counting to a certain count, have opportunities to discuss chance in the context of the leader's choices of locomotion and various contexts. It is an opportunity to count together aloud and work together with the same rhythm or beat.

Australian Curriculum Mathematics Outcomes and elaborations:

*ACMSP024

**ACMNA002

***ACMMG023

Numeracy Links:

* Identify outcomes of familiar events involving chance and describe them using everyday language such as 'will happen', 'won't happen' or 'might happen' justifying that some events are certain or impossible

** using scenarios to help students recognize that other cultures count in a variety of ways, such as the Wotjoballum number systems

*** Give and follow directions to familiar locations

Australian Curriculum Subject outcomes and elaborations:

Explore, improvise and organise ideas to make dance sequences using the elements of dance (ACADAM001) exploring fundamental movements safely to improvise dance ideas,

The Learning Task: Dance: Year 1—Chance Dance

This task combines counting, chance vocabulary, rhythm and dance whilst providing opportunities for students to safely explore movement and create moments for creative input.

Including ATSI perspectives: This task is focussed on counting in a very precise Western way of thinking about and naming number that is not the most instinctive way for some students in this group to think conceptually about quantity. The timing is about duration which again presents a Western notion of measuring and explaining time. Approaching these conceptual differences, which may call for code switching, through dance activities can be supportive for students whose home and community environments may use traditional concepts of quantity and time. The students may particularly enjoy these activities also because dance is a traditional means of knowing, learning and communicating.

Strategies to include learners with oral backgrounds: This activity is a particularly useful approach to use for these students. Like ATSI students, many specific cognitive capacities have been developed by those with an oracy tradition. These rely heavily on performance participation, movement and action and conceptual understandings expressed as dance. Parts of this activity really need no language and students can adapt this notion to express any number of ideas, information and narratives without the use of language. It is possible to build number names and sequences and ensure one to one correspondence skills using dance and rhythm for these and all students.

Authentic Assessment strategies:
Observation:
Were students able to copy the teacher's locomotor and still movements accurately?
Were students able to perform their stills, while counting out loud from 1 to 8, in time with the teacher and/or the beat of the music when performing the dance?
Were students able to accurately record and perform their movements in the correct number sequence of the dice rolls?
Were students able to change the movements of the dance, when working in pairs, during the student centred activity?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally in classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

- Teacher reads the story again, stopping when required to allow students time to perform the movements in response to the text*. This time, students perform the movements without support from the teacher. Teacher affords prompts if/when required.
- Students perform the dance again, expressing the narrative through their movements without the teacher reading the story aloud. Because students will finish the dance at different times, they will end their dance by climbing back into their mother's pouch.
- Students remain curled up into a small ball with eyes closed until every student has completed their dance.

Dance: Year 1—Chance Dance

Resources MP3 or CD player, lively music, six-floor markers numbered from 1 to 6, a number of six-sided dice, paper or student workbooks to record number sequences on.

Create a chance dance to explore locomotor movement and still (held body shapes)
Place six markers, numbered from 1 to 6, evenly around the performance space. Students will roll a six-sided dice, three times, and record each number in the order they occurred.

Students will (i) explore locomotor movement by moving from one space to the next following the number sequence of their dice rolls and (ii) hold a still (a held body shape) for 8 counts, on the markers that represent these numbers.

Warm-up: Play a lively piece of music and have students move when they hear the music, and perform a still when it is paused. Teacher directs the warm-up by calling out the locomotor movement or the shape to hold during the still. Calls should be made before the music is played for the locomotor movements, and after it has stopped for the stills. The music can be played for 10–15 s and paused for 5–10 s.

Calls can include: (i) Locomotor: Run forward using small steps, skip and swing arms, hop on one foot following a curved pathway, slide sideways to the left (ii) Still: create a tall-twisted shape, hold a wide shape, copy the shape of an object in the room, create a low-curved shape.

Detailed organisation and implementation

- Throughout these activities, students can continually predict 'possible' and 'impossible' and use the language of chance indicated in the outcome. For example, discuss the possibility of getting a 4 and the impossibility of getting a 7*.

Differentiation: This task can be implemented in any number of contexts that include opportunities for the students to hold 'still' while counting to a certain count, have opportunities to discuss chance in the context of the leader's choices of locomotion and various contexts. It is an opportunity to count together aloud and work together with the same rhythm or beat.

Australian Curriculum Mathematics Outcomes and elaborations:

*ACMNA002

**ACMNA026

***ACMMG066

Numeracy Links:

*Connect number names, numerals and quantities, including zero, initially up to 10 and then beyond

** Investigate number sequences, initially those increasing and decreasing by twos, threes, fives and tens from any starting point, then moving to other sequences

***Identifying symmetry in the natural and built environment

Australian Curriculum Subject outcomes and elaborations:

Explore, improvise and organise ideas to make dance sequences using the elements of dance (ACADAM001) exploring fundamental movements safely to improvise dance ideas,

The Learning Task: Dance: Year 2—Sports Dance

In the development of this dance the students count as they move around and engage in the dance

Including ATSI Perspectives: This task is focussed on counting in a very precise Western way of thinking about and naming number that is not the most instinctive way for some students in this group to think conceptually about quantity. The timing is about duration which again presents a Western notion of measuring and explaining time. Approaching these conceptual differences, which may call for code switching, through dance activities can be supportive for students whose home and community environments may use traditional concepts of quantity and time. The students may particularly enjoy these activities also because dance is a traditional means of knowing, learning and communicating and sport is the

Strategies to include learners with oral backgrounds: This activity is a particularly useful approach to use for these students. Like ATSI students, many specific cognitive capacities have been developed by those with an oracy tradition. These rely heavily on performance participation, movement and action and conceptual understandings expressed as dance. Parts of this activity really need no language and students can adapt this notion to express any number of ideas, informatio and narratives without the use of language. It is possible to build number names and sequences and ensure one to one correspondence skills using dance and rhythm for these and all students.

Authentic Assessment strategies:
Observation:
Were students able to represent the three different sports successfully using their bodies (solo and in pairs)?
Were students able to perform their movements in time (e.g. hitting the ball on counts 1, 2, 3, 4 in the cricket section of the dance)?
Were students able to perform the movements in the correct sequence of the culminating dance?
Were students able to change the sequence of the dance during the second performance of the work?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally in classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

- Teacher rolls dice and moves to the marker that displays the same number as the dice in the performance space. Use one of the locomotor movements experienced in the warm-up. Students copy teacher. Teacher explains that the first marker is like first base, and is where we will perform a still for 8 counts. Students copy teacher performing one of the stills from the warm-up, while counting out loud to 8 with the teacher**.
- Teacher rolls the dice two more times and repeats previous step each time. Make sure to change the locomotor movement and still for each location (second and third base).
- Teacher rolls dice three times and records the numbers in the sequence they were thrown. Repeat steps one and two again following the number sequence of the dice rolls. Ask students to improvise their own locomotor movements and stills this time. Teacher supports students, counting out loud at each of the three bases when holding their stills**.
- Organised in pairs, students roll a six-sided dice three times and record their number sequence. Students are then asked to choose a leader, who will improvise the locomotor movements and stills throughout the Chance Dance, the follower will copy the leader's movements. Pairs switch roles and repeat the dance***.
- Students can roll two number sequences, and explore a different pathway when repeating the dance with the new leader, or they can add the two number sequences together to perform a longer dance with (six numbers in total)***.

Dance: Year 2—Sports Dance

Resources MP3 or CD player, Inspirational music. For example, *Chariots of Fire* by Vangelis Papathanassiou, Signs indicating the sporting events that will be represented in the dance.

Create a dance about ball sports

Pretend we are in a large stadium surrounded by thousands of supportive fans cheering us on. What sporting events might we see in a stadium? Ask students to share their favourite sport, and/or a sport that is popular in their country/culture, and/or a suitable recreational activity for students less interested in sport. Allow students to select three sports/recreational activities to base their dance on (e.g.

cricket, basketball, and tennis). Students draw and place a sign for each sport/recreational activity they selected on the walls of the performance space. In each of these spaces, students will be performing movements that represent their chosen sport and/or recreational activity.

Warm-up: Walk around the perimeter of the performance space while waving to the crowd. Encourage students to use big movements by taking large slow steps and big waving arm movements; next, have student skip, run, or gallop around the space. Engage students' imagination by asking them if they can hear the crowd roar as they move around the stadium. Once complete, ask students to find a personal space and then copy the teacher performing movements that represent catching a ball: stretching up high, bending down low, stretching to one side, and then the other. Ask students to lead the warm-up by performing movements inspired by their favourite sport/recreational activity.

Detailed organisation and implementation

- In the performance space marked by one of the sports/recreational activities, students copy the teacher, performing slow, large movements that represent their favourite sport/recreational activity. For example, when representing cricket, students could perform a straight drive, or a shot to the right or left of the body. Count aloud as you perform these movements*. For example, hitting the ball on counts 1, 2, 3, 4; then returning to the starting position on 5, 6, 7, 8. Next, students face each other in pairs. Student 1 is asked to perform different cricket shots to the count of 8. Student 2 is the catcher and holds body shapes that represent catching a ball for 8 counts. More complex activity: student 2 can begin their freezes on the count of 5 instead of 1**. Pairs switch roles and repeat task.
- Students copy the teacher walking, skipping, or galloping to the performance area marked by students' second sign. Ask students to discuss and/or demonstrate the types of movements they have seen in their second sport or recreational activity? Students perform their individual movements in time with the teacher. Encourage students to make the movements as large as possible. Movements could include bouncing the ball with right then left hands (on counts: left, left, left, left, right, right, right, right), passing and catching a ball (on counts: pass, 2, 3, 4, catch 6, 7, 8), and shooting for goal (4 or 8 counts total). Next, make students to move around the performance space, using locomotor movement, while performing the actions. Encourage students to explore different ways they can move through space. For example, skip, gallop, walk, or by moving backwards or sideways.
- Students copy the teacher walking, skipping, or galloping to the performance area marked by the third sign. Repeat previous step, but this time, focus on the movements represented by students' third activity.

- Combine the three sections of the dance together and ask students to perform the movements in the same order as they learnt them the first time; the second time, they can choose which order to perform them in.
- Draw a simple map of the activities, displaying the correct starting point, and dots or numbers to indicate the correct sequence of the activity. Draw a line between each activity areas (i.e. the dots or numbers used to indicate where the activity occurred and the order they occurred in) and describe the shape it creates as either symmetrical or asymmetrical. If asymmetrical, were any of our body shapes also asymmetrical***?

Differentiation: This task can be implemented in any number of contexts that include opportunities for the students tell stories of growth and diminishment. Ideal context could be the gradual, asymmetrical and then symmetrical growth of a flower, followed by its gradual dying away. Any focus on the cycle of life can be used in the context of this lesson.

Australian Curriculum Mathematics Outcomes and elaborations:

*ACMMG045

**ACMMG066

***ACMMG042 and/or ACMMG063

Numeracy Links:

*Investigate the effect of one-step slides without digital technologies

**identify symmetry in the environment

***Describe and draw two-dimensional shapes without digital technology and/or make models of three-dimensional objects and describe their features

Australian Curriculum Subject outcomes and elaborations: Improvise and structure movement ideas for dance sequences using the elements of dance and choreographic devices (ACADAM005) altering movements in a set, teacher-directed or student-devised dance using the elements of space, time, dynamics and relationships to express ideas, for example, increasing the size of a movement to represent growth

The Learning Task: Dance: Year 3—Symmetry Dance

This task is an opportunity to begin the conceptual understanding of symmetry and asymmetry through dance. This work can be built on at a later stage to develop a dance about rotational symmetry – flip, slide and turn. In this case it can tell a narrative around growth and diminishment.

Including ATSI perspectives: This task could be developed to tell any number of ATSI legends, traditions, and lifespans, including those associated with the land, community and important family, 'mob' and personal stories for the whole class. Linking this with narrative and the land is very supportive of ATSI ways of knowing and learning. The mathematical language can be understood by construction and deconstruction

Strategies to include learners with oral backgrounds: This activity is a particularly useful approach to use for these students. Like ATSI students, many specific cognitive capacities have been developed by those with an oracy tradition. These rely heavily on performance participation, movement and action and conceptual understandings expressed as dance. The mathematical metalanguage can be interpreted through the actions and participation of the dance. It may be wise to consider the personal circumstances of the individual students in the class if considering to use the dance as life cycle. It may be a an emotional issue for some of these students.

Authentic Assessment strategies:
Observation:
Were students able to represent symmetrical and asymmetrical shapes successfully using their bodies (solo and in pairs)?
Were students able to transition between the different shapes and sections of the dance using logical, flowing and balanced movements?
Were students able to perform the movements:
Within the structure of the work?
In a new structure?
Without the teacher's assistance?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally in classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

Dance: Year 3—Symmetry Dance

Resources MP3 or CD player, flowing/slow tempo music, picture, Art work and/or objects that provide examples of symmetry and asymmetry.

Create a dance about symmetrical and asymmetrical shapes
Display images with symmetry and asymmetry and discuss the features that help us identify them. Can anyone see a symmetrical shape in the room? An asymmetrical shape in the room? **Warm-up**: Student copy teacher performing symmetrical and asymmetrical shapes with their bodies. Shapes should include reaching up high; bending down low; twisting; balancing on one foot with raised leg extended in front, behind, or to the side; small and large movements. Ask students to pair up and practice symmetrical shapes that require their partner to remain balanced (i.e. holding hands while leaning away from each other). Repeat step using asymmetrical shapes. Students copy teacher exploring symmetrical shapes using locomotor movement. Repeat step using asymmetrical actions. Locomotor movements can include walking, hopping, skipping, leaping, running, jumping, and/or sliding*.

Detailed organisation and implementation

- In their own personal space, students create a low symmetrical shape with their body (i.e. lying on the floor, crouching, or resting on one or both knees). Students make another symmetrical shape on signal (i.e. drum hit, hand clap, etc.) and then another (Section 1)**.
- Discuss the term transition to students (i.e. moving from one dance action and/or space to another in a logical and flowing way). Demonstrate a transition from crouching, kneeling, or laying on the floor to standing tall, while focusing on balance and flow. Ask students to practice transitioning from the floor to standing tall in their own time. Repeat this step until students are comfortable moving with balance and flow. Encourage students to use two points of contact on the floor at any one time (e.g. left foot and right hand).
- Standing in their own personal space, students create high asymmetrical shapes with their body (e.g. standing on one leg with arms outstretched, or with legs together and one arm extended to the front, the other bent across the body). Students make another symmetrical shape on signal and then another (Section 2)**.
- Ask students to find a partner and create symmetrical shapes that require their partner to remain balanced (e.g. holding hands while leaning away from each other). Pairs make another symmetrical shape on signal and then another (Section 3)**.
- Ask students to find a personal space and transition back to the floor where they will hold low asymmetrical shapes with their bodies on signal (Section 4)**.
- Combine the four sections of the dance together and inform student to perform the movements in the same order as they learnt them the first time; the second

Differentiation: Pictures and/or words that describe each circus event, can be written on the whiteboard or displayed on a projector to support the task. The students can have turns at being the ringmaster and perhaps change the order of the performances. Students who are not ambulatory may be able to be the ringmaster or to join in the activities using their arms, hands or other body parts. Other students may enjoy cuing systems that are not noisy.

Australian Curriculum Mathematics Outcomes and elaborations:

*ACMMG085

**ACMMG091

Numeracy links:

*Convert units of time

**Create symmetrical patterns or shapes without digital technology

Australian Curriculum Subject outcomes and elaborations:
Perform dances using expressive skills to communicate ideas, including telling cultural or community stories (ACADAM007) exploring the elements of dance to communicate ideas clearly, such as telling cultural stories in a dance with or without music;

The Learning Task: Dance: Year 4—Circus Dance

This task engages students with notions of performance, audience participation, timing and converting one unit of time to another (seconds, minutes) symmetry (mime artists) and provides opportunities for sharing cultural, social and personal narrative in dance.

Including ATSI perspectives: The topic of this performance may not be appealing to all ATSU students. However, this type sequencing activity that relies heaving on timing and pacing to drum beat, triangles or other untuned instruments can be performed with any other audience in mind, replacing the characters and animals with native animals and hunters, native instruments and music and so use the 'performance' to retell a different narrative of cultural and social importance to all the students.

Strategies to include learners with oral backgrounds:

Some of these students may not have seen a circus as culturally portrayed in this task, but they may have seen a variety of cultural and social performances which involved animals. If not, then they may be able to connect with the ceremonial aspects of dance and traditional music at celebrations such as births, initiations, rites of passage and marriages. These may provide an ideal opportunity to further engage in the tasks as all the students may wish to demonstrate their experiences of cultural and social events and audience participation as narrative dance.

Authentic Assessment strategies:
Observation:
Were students able to represent the four different circus acts successfully using their bodies (solo and in pairs)?
Were students able to transition smoothly from one act to the next, or when changing direction, etc, during the performance of the dance?
Were students able to perform the movements in the correct sequence of the culminating dance?
Were students able to successfully perform the dance without the assistance of the teacher?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally in classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

time, they can choose which order to perform them in. Teacher supports students the first time though. Encourage students to use logical and flowing movements when transitioning between each section of the dance. Teacher cues movements by hitting drum or clapping hands throughout the performance.

- Design a follow-up lesson on 2D and/or 3D symmetrical and asymmetrical shapes***. Begin the lesson with a reflection on the type of shapes students represented with their bodies in this lesson.

Dance: Year 4—The Circus

Resources MP3 or CD player, Circus like music or lively music, chalk or taped lines on the floor for tightrope walking, a top hat and/or cane for the ring master (teacher), untuned percussion instrument if desired (i.e. drum or triangle).

Create a dance about the circus
Pretend we are in a large circus tent surrounded by an excited audience, waiting for our performance. Has anyone been to the circus? What did you see? **Warm-up**: gallop like a horse, twice around the perimeter of the performance space. Ask students to use small locomotor movements the first time around, and large ones the second time. Engage students' imagination by asking them if they can hear the crowd clap and cheer as they prance around the stadium? Once complete, ask students to find a personal space and then copy you performing movements that represent a funny juggling clown (use large circular movements, and encourage students to visualise the balls as they move in the air); a mime artist (begin with students copying your actions, then, by doing the opposite of your actions). For example, when you move up, students move down; Walking backwards and forwards with arms extended out like a tightrope walker (imagine you are walking along a tightrope by placing one foot in front of the other).
These are just suggestions, a student-centred approach would involve exploring the movements of circus acts and/or animals that your students identified at the start of the lesson.

Detailed organisation and implementation

Note: below is an example of the type of movements and actions you can explore throughout the lesson; however, a student-centred learning environment would allow students to bring their own experiences and knowledge into the activity. For example, you could replace juggling with a lion and lion tamer movements.

- Students copy teacher making hand and arm shapes that imitate the two front hooves of a horse. Explore hand width (close together or far apart) and height (one hand higher than the other and vice versa)**. Next, students gallop in a small circle, then a large circle, around the entire performance space. Add leaping in the air when the teacher claps hands, or hits a triangle or drum when galloping. Ask students how many counts were between each movement cue* (i.e. teachers hand clap or instrument hit). Students can gallop in groups with one horse as leader to guide the pathway or design different formations in a group of four.
- In their own space, students copy teacher performing juggling movements. Make the movements as large as possible and have students imagine that they are watching the ball as it moves from one hand to the other in a large overarching shape above their heads. Add locomotor movements such as walking forwards or backwards, sliding sideways, or turning in a small circle. Ask students to suggest other ways to juggle, including low on one knee, on their backs, or balancing on one foot with free leg extended behind body**.
- Use lines on floor as tightropes and ask students to walk forwards and backwards along the line with arms extended out to the side. Next, students turn, jump, or hop as the move along the line. Next, students practice holding a shape for 4 counts during their tightrope walk, then another**. Encourage them to find a balancing point during their stills. Can they do it on one leg, or when their torso is extending out from the body? The teacher can clap hands, or play a triangle or drum to indicate when and for how long stills are performed. Ask students if the movement cues are the same distance apart in time as the previous ones in step 1 of the lesson, or were they longer or shorter in time*? Were the cues always the same space apart in time or different? If the same, how many beats were there between each movement cue*?
- In pairs, students practice being mime artists. One student is the leader, and performs slow, large movements that the other student copies. Next, try opposite movements to what the leader performs. Explore high and low, or locomotor movements while performing their mime. Encourage pairs to use slow,

repetitive movements that support their partner's timing of the movements. Switch roles and repeat.

- Combine the four dances in the sequence they were explored in the previous steps. Ask students to form a single line, or be organised into groups of three or four before the dance begins. Play music and conduct the activity by announcing each event as they occur in the dance form. For example, '… and now ladies and gentlemen, we have the amazing galloping horses!' Teacher guides students through each activity, by providing visual and verbal cues when required. Students begin by galloping in a small circle, and then in a larger one, etc.

A more student-centred approach would involve students interpreting their own circus acts, design their own unique movement sequences, and if desired, select one student in each group to be the conductor/ring master.

Differentiation: This task can be implemented in any number of contexts that include opportunities for the students to hold 'still' while counting to a certain count. This can be altered to accommodate any number of bodily kinaethetic activities

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Australian Curriculum Mathematics Outcomes and elaborations:

*ACMNA113

**ACMMG142

Numeracy Links:

*Continue and create sequences involving whole numbers, fractions and decimals. Describe the rule used to create the sequence.

**Investigate combinations of translations, reflections and rotations, with and without the use of digital technologies.

Australian Curriculum Subject outcomes and elaborations:
Explore movement and choreographic devices using the elements of dance to choreograph dances that communicate meaning(ACADAM009)

improvising new movement to communicate ideas in response to stimulus,

The Learning Task: Dance: Year 5—Sports

The students in this dance use their knowledge of sports to create movement for the dance. They may incorporate other bodily kinaesethic activities that may not be class as sport exactly, but which are hobbies or pastimes. Each time the students stop any section of their dance and 'still' they note their grid reference They can then plot their ending points on

Including ATSI perspectives: This task is focussed on counting in a very precise Western way of thinking about and naming number that is not the most instinctive way for some students in this group to think conceptually about quantity. The timing is about duration which again presents a Western notion of measuring and explaining time. Approaching these conceptual differences, which may call for code switching, through dance activities is supportive for students whose home and community environments may use traditional concepts of quantity and time. The students may particularly enjoy these activities also because dance is a traditional means of knowing, learning and communicating and sport is the focus.

Strategies to include learners with oral backgrounds: This activity is a particularly useful approach to use for these students. Like ATSI students, many specific cognitive capacities have been developed by those with an oracy tradition. These rely heavily on performance participation, movement and action and conceptual understandings expressed as dance. Parts of this activity really need no language and students can adapt this notion to express any number of ideas, information and narratives without the use of language. It is possible to build number names and sequences and ensure one to one correspondence skills using dance and rhythm for these and all students.

Authentic Assessment strategies:
Observation:
Were students able to represent their chosen sport through dance actions successfully?
Were students able perform their movements in time? For example, a movement that lasted two beats each, or a single movement lasting 4 beats.
Were students able to perform the movements in the correct sequence of the dance?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally in classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

Dance: Year 5—Sports

Resources MP3 or CD player, Music with a clear beat. For example, Birthday by Katie Perry, Whiteboard or plain A3 paper to record student's favourite sports on to. Chalk to make grid.

Create a dance about sport

What is your favourite sport? Notate students' answers on the board. What movement(s) is unique to your favourite sport? **Warm-up:** Student's jog on the spot and perform stills (a frozen body shape) that reflect the sports highlighted on the board. Teacher supports the warm-up, by calling out the sport that students are to imitate in their stills, to the structure—jog, still 1, jog, still 2…

Detailed organisation and implementation

- Students stand in circle formation, organised into groups of 5 or 6. Students are assigned a consecutive number from 1 to 5(6) in each group. Each student selects a sport and one movement from that sport. Allow students time to practice and perfect their movement for 4 counts.
- Groups combine their movements to form a larger work by following the structure**:
  - Student 1 performs their four-beat movement to the group which is then echoed in unison by the other group members. Students can choose to perform the movement four times, timed to the beat, or they can perform the same movement twice, with each movement taking two beats to complete, or a single movement that is four-beat long.
  - Student 2 then performs their four beat movements to the group, which is again echoed in unison by the other group members.
  - The first and second movements are then combined and performed in unison to form a larger work (8 beats total).
  - Student 3 then performs their four-beat movement to the group, which is again echoed in unison by the other group members, then the three movements are joined together to form a larger work.
  - The process is then repeated until every student has added a movement to the dance sequence*.
- Once students have developed and memorised their dance, ask them to revise their movements, by reflecting on their use of space, the force of their movements (soft and flowing or strong and dynamic), and/or by making the movements as large as possible**.
- Each group performs their dance to the class. Students in the role of audience are asked specific questions by the teacher about:
  - What sports were the movements representing?

Differentiation: This lesson structure can be applied to any type of narrative that the students suggest and enjoy. There is a differentiated task at the end of the lesson which provides for student creativity and alteration or accommodation to the task. Students who are not ambulatory can be helped with the arm movements and similar adaptions made for any number of student contexts

Australian Curriculum Mathematics Outcomes and elaborations:

*ACMMG111

Numeracy Links:

*Connect three-dimensional objects with their nets and other two-dimensional representations.

Australian Curriculum Subject outcomes and elaborations:
Explore movement and choreographic devices using the elements of dance to choreograph dances that communicate meaning(ACADAM009) improvising new movement to communicate ideas in response to stimulus,

The Learning Task: Dance: Year 6—A Day at the Beach

This task is an inclusive task in many ways. It is a translation of 2D into three dimensionally and includes an opportunity for students to carefully craft a narrative that reflects an activity in the natural environment through dance.

Including ATSI perspectives: This task is focussed on exploring the activities in the natural environment by using dance. It is particularly well suited to these students as storytelling through dance is part of their traditional culture and heritage and is a culturally appropriate way of knowing and passing on knowledge. This is a good opportunity for all students to use traditional dances if appropriate. Consult with community leaders or parents for advice.

Strategies to include learners with oral backgrounds: This activity is a particularly useful approach to use for these students. Many specific cognitive capacities have been developed by those with an oracy tradition which rely heavily on performance participation, movement and action and conceptual understandings expressed as dance. This activity really needs no language and students can adapt this notion to express any number of ideas, information and narratives without the use of language. To use traditional dances community leaders and parents should be consulted regarding appropriate selection and respectful execution of dance s.

Authentic Assessment strategies:
Observation:
Were students able to represent the four different beach movements successfully using their bodies?
Were students able to perform their movements in time to the beat?
Were students able to perform the movements in the correct sequence of the culminating dance?
Were students able to change one of the dance sections using movements that support the dance narrative?

Variations for students from diverse social contexts: In some groups dance is reserved for specific people, events and ceremonies. Often there is no gender mingling in the dance. There are dances reserved exclusively for males and exclusively for females. Some Islamic groups reserve dance, music and singing exclusively for occasions of religious worship and it is not used generally ion classrooms. There are many occasions when dance audiences are restricted also so if encouraging students to participate in modern, school or traditional dance activities, it is wise to observe cultural and social protocols.

  - Can someone demonstrate one of the movements from the dance we just observed? If yes, what did you like most about that movement?
  - Did any of the movements in the dance take four beats to complete? Were any movements two beats long?

- Students stand together to form one large circle. Mix students up so that no two group members from the same group are next to each other. Once organised, perform all group dances at the same time. Because groups will end at different times, ask students to hold their last action as a still until every group has completed their dance.
- Extension: Half of one group can join another. Students are then asked to teach their dance to their new group members and then combine their ideas to form a larger work*.

Dance: Year 6—A Day at the Beach

Resources MP3 or CD player, music with the sound of ocean waves, pictures or video of waves or swimmers, drum or other untuned percussion instrument to perform beat.

Create a dance about a day at the beach
Pretend we are going to the beach for a swim, or if students are not familiar with this experience, allow students to choose a similar event to base their dance on (e.g. a day at the creek, park or dam). Has everyone brought their sunscreen, swimmers and towel with them? Choose four beach activities and/or environmental stimulus to base our dance on (travelling to the beach, swimming in the ocean, waves and towelling off to dry). Display images that symbolise each beach activity in the sequence they occur in the dance. **Warm-up**: Students walk around the performance space using big movements. Encourage students to imagine they are walking to the beach, with each step timed to the beat, which is clapped or performed on a drum by the teacher. Ask students to add high and low movements, add swinging arms, or change direction every four or eight beats while walking. Next, students perform movements that represent waves, by moving their hands and arms slowing up and then down to the motion of a wave. Encourage students to make the movements as big as possible, by reaching high to the ceiling and low to the floor, on beats up, up, up, up, down, down, down, down.

Detailed organisation and implementation

- Inform students that they will be performing movements that represent riding a bicycle, scooter, or skateboard to the beach. What type of movements could we use to express these kinds of transport*? What pathways can we follow when riding our bicycles, etc. (e.g. zigzag, curved, straight, or winding)? Students join teacher riding to the beach, by moving from one side of the room to the other, following their own pathway. Next, change direction and repeat step using a different pathway, mode of transport, or both.

- In their own personal space, students copy teacher performing hand and arms movements that imitate the motion of an ocean wave*. Demonstrate large up and down movements, as discussed in the warm-up, for students to copy. Next, ask students to add full body movements that support the up and down hand and arm motions*. Time the movement to the beat up, up, up, up, down, down, down, down. Perform the movement sequence twice, movements larger the second time while walking, skipping or galloping forward on the beat.
- What type of movements do we make when swimming*? Encourage students to use movements that alternate their arms, followed by movements the move their arms together and then movements that alternate between moving together, followed by moving independently. Add walking, skipping or galloping forward on the beat while performing the swimming arm movements. Next, divide the class into two even groups, positioned on either side of the room. One group performs the wave movements, the other, the swimming actions. Each group will move across the room, passing through the other group members. When each group reaches the other side of the room, they switch roles.
- We have finished swimming; we need to towel off to get dry. Can someone show me how they dry themselves off with a towel*? Encourage students to make the movements as large as possible, and to time their actions to the beat. Can we bend down low to dry our feet, then up high to drying our hair? What other movements do we use when drying off with a towel? Class copies student's movement suggestions.
- Combine the three sections of the dance together and inform students to perform the movements in the same order they learnt them in. Wave movements and swimming actions occur at the same time (see step 3 of 'Detailed Organisation and Implementation').
- In groups of 4–6, ask students to change one of the dance sections, and then perform the new work to the class. Groups can change one of the actions learnt in the dance, or create an entirely new section in line with the dance narrative*.

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Drama in the Primary Classroom: Contextualising Critical Numeracy

Rachel Burke and Heather Sharp

Introduction

> A child who was particularly shy, spoke very little and seldom chose to participate in role-play had spoken to his teacher about his recent visit to Scotland by train. The following day chairs and tables were moved around to represent a train and all the seats were numbered, with some marked as 'Reserved'. 'Passengers' were allocated tickets. Different children took on roles such as the train driver, holidaymakers or office workers and the boy was encouraged to become the train manager. He engaged in the role-play with other children after the teacher asked him a key question: 'Will I be able to buy refreshments on this train?' This prompted him to perform in role, using the 'intercom' to announce that the train shop was open. He then proceeded down 'the aisle', asking 'passengers' their destination and checking 'tickets' at the same time (The Arts Council of England, 2003: 9).

This description of a simple role-play in the primary classroom illustrates the potential for drama to transform the learning environment. An imagined scenario provides a novel context for participation, learners are empowered to share 'ownership' of the classroom assuming various roles in the drama and there is a conscious effort to build on learners' existing knowledge. Although not identified in the description of the role-play, there are a range of numerate concepts, skills and dispositions inherent to the scenario. The spatial arrangement of furniture to replicate the setting of a train carriage, the numbering of the chairs, the allocation of tickets and roles to each learner, and possibly transactions related to the purchasing of food at the dining car, all require numerate skills and knowledge. Further, in participating in the scenario, the learners assume particular social roles. The

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introduction of drama, therefore, provides a meaningful context for engagement with numeracy.

The Victorian Department of Education and Early Childhood Development (2009: 7) asserts: 'for students to become numerate, they must be given opportunities to practise and apply the mathematics they have learned, not only in the mathematics classroom but also in other areas of the curriculum'. With its attention to 'the expression and exploration of personal, cultural and social worlds' (ACARA, 2013: 51), drama contains rich and meaningful opportunities for exploring and applying numerate concepts, skills and dispositions. This chapter will consider potential links between numeracy and the Australian Curriculum: The Arts, with specific attention to drama. The activities included at the end of the chapter are intended to illustrate the potential for drama content, principles and techniques to scaffold learner development in critical numeracy within the primary classroom.

Drama: An Important Forum for Numeracy Education

A growing body of research evidences the significance of quality drama instruction for learner success across a range of academic and affective domains in schooling and beyond (Baldwin, 2006, 2009; Crumpler, 2007; Edmiston, 1993, 2007; Ewing, 2009; Fiske, 1999; McMaster, 1998; Roy, 2014). Whilst frequently experienced as existing on 'the fringes of the formal curriculum' (Ewing, Hristofski, Gibson, Campbell, & Robertson, 2011: 22) and afforded less status than other subjects (Hundert, 1996, Roy, 2014), drama involves core content, cognitive skills and critical dispositions identified as essential outcomes for twenty-first century schooling. In fact, with its intention to 'entertain, challenge, provoke responses and enrich our knowledge of self, communities, world cultures and histories' and to 'contribute to the development of confident and creative individuals, nurturing and challenging active and informed citizens' (ACARA, 2013: 3), education in the Arts incorporates content from every Key Learning Area (KLA), including mathematics.

Importantly, drama education parallels the imaginative role-play and make believe that forms an essential part of children's socialisation (Rowell, 2010). The NSW Department of Education and Communities (n.d., n.p.) further asserts, 'Each individual's interpretation of the world draws on understandings of number, measurement, probability, data and spatial sense combined with critical mathematical thinking'. The exploration of numeracy through drama may still be considered a novel practice (Gerofsky, 2011). Gerofsky (2011: 329) advises: 'where the arts have been accepted into mathematics instruction, it is far more likely that they will be visual and sculptural media used for representing mathematical objects and relationships'. However, there is enormous potential for significant connections between drama and numeracy (Gerofsky, 2011; Roy, 2014).

Numeracy in the Australian Curriculum: The Arts

In contrast to other KLAs, the current Arts curriculum, drama, contains minimal explicit links to numeracy. However, broad statements about the importance of numeracy as a 'General Capability' within the Arts provide educators with a starting point for considering numerate links (ACARA, 2013: 19). ACARA (2013: 19) identifies a number of situations in which learners may be required to engage with numerate practices including the use of:

> number to calculate and estimate; spatial reasoning to solve problems involving space, patterns, symmetry, 2D and 3D shapes; scale and proportion to show and describe positions, pathways and movements; and measurement to explore length, area, volume, capacity, time, mass and angles. Through making and responding across the Arts, students use numeracy skills to choreograph and perform dance; build, rehearse, sequence and time plays; plan, direct and edit media texts; compose, produce and record music; and design, construct and display art. Students work with a range of numerical concepts to organise, analyse and create representations of data relevant to their own or others' artworks, such as diagrams, charts, tables, graphs and motion capture.

Within this broad statement, a number of numerate behaviours, skills and dispositions are evident. In 'mining' the drama curriculum for numeracy links, teachers may find it useful to consider the numerate behaviours and skills that emerge from both the *content* of drama—the real and imagined scenarios created—and the *process* of drama—the procedures for designing, conducting, critiquing and recording performances. The content of dramatic performance may include any number of mathematical concepts—exploring the surface of Mars—as Edmiston (2007) describes in his discussion of drama as a means of inclusive literacies instruction—may require a range of numerate practices. Boarding the space ship and counting down until take off or landing, calculating the number of craters or volcanoes on the planet's surface and measuring the size of life forms encountered during the exploration are just some of the numerate behaviours that may be relevant to such an activity. The process of creating and exploring Mars might require spatial arrangement of the classroom or stage to create representations of the volcanoes, dry lakebeds and craters, deciding how many items such as space helmets may be needed to include all performers playing the role of astronauts, and determining how much time to allocate to various parts of the performance. Several key areas of numeracy pertaining to the aspects of drama content and process will now be examined.

Creating Real and Imagined Worlds: Spatial Knowledge

Drama provides a rich forum for the exploration of physical space. The example at the beginning of this chapter illustrates how simply modifying the arrangement of furniture and adding signs and other props can transform a typical classroom setting. Importantly, when engaging with space, learners are utilising essential numerate knowledge and skills. Estimation and measurement, scale and proportion, and orientation and shape are important elements of the exploration of space within the drama. Measuring the distance between objects, understanding connotations of importance or strength associated with size, exploring the notion of scale (for example, the ratio of dimensions in a drawing of the set design when compared with the final product) and the position of objects in the foreground to indicate significance, are all examples of numeracy within spatial exploration in drama.

Further, Roy (2014) identifies the process of blocking a scene as another important connection with numeracy. Blocking, a term possibly derived from the nineteenth century theatre directors' use of blocks to represent actors on miniature models of the stage, refers to the positioning of actors throughout the performance (Werner, 2015). Visibility and lighting considerations, as well as intended dramatic effect, require learners to consider angles, position and movement when deciding on where to place actors. The stage directions are another component of navigating the performance space, with learners required to understand terminology such as 'downstage right' or 'upstage left' (Roy, 2014). Participation in these elements of the process of drama, therefore, involves a range of numerate skills.

Exploring Patterns Through Drama

A key element of numerate problem solving is the ability to identify, describe, predict and create patterns (Taylor-Cox, 2003). The arrangement of objects or events in a sequence occurs in various forms in everyday life. Copley (2000: 83) advises,

> Children watch the sun setting every day; listen to stories, songs, and verses that follow patterns; notice how a puppy plays and sleeps on a schedule; jump rope to patterned chants; and skip over sidewalk bricks laid in patterns.

Drama, with its emphasis on engaging with real and imagined worlds, naturally lends itself to the exploration of patterns as they occur in a variety of contexts. ACARA (2013: 27) asserts 'Creating patterns in the Arts involves counting, measurement and design in different ways across the various art forms'. By providing opportunities to be creative in a range of modalities, drama can encourage learners to engage with patterns through movement, song, rhyme and narrative. Returning to the example from the beginning of the chapter, the transformation of the classroom into a train could be further enhanced by the inclusion of other modalities to set the scene.

For very young learners, a simple repeating pattern containing recurring elements such as clapping and tapping can be an important way to engage with sequencing and order (Taylor-Cox, 2003). Alternatively, learners can move around the classroom to form lines sequences or participate in a role-play where patterns are an important component, for example placing blocks in a growth pattern in order to create the 'staircase' to a magical castle. There are also songs and rhymes structured around various types of patterns (Taylor-Cox, 2003). *Maths Chants* by Margerm (2009) provides a range of numeracy related rhymes that can be creatively performed using gestures, movement, voice and facial expressions to increase dramatic effect.

Understanding Change

Taylor-Cox (2003) identifies the importance of mathematical knowledge as a way of describing and predicting change. She refers to qualitative change as those events that are 'described with relative mathematical labels such as smaller, taller, and fuller' and 'occur over time and are fairly predictable' (Taylor-Cox, 2003: 20). Examples include shoes becoming tighter as children grow or a bucket filling with water during a rain shower (Taylor-Cox, 2003). In contrast, 'Quantitative changes are also part of children's lives: The child's shoe size changes from 10 to 11; the sunflower grows 3 cm in one week' (Taylor-Cox, 2003: 20). Taylor-Cox (2003: 20–21) identifies the prominence of predictable change within narratives, suggesting, 'The opportunities for algebraic thinking are nearly endless'.

Combining drama techniques, such as role-play scenarios, may be a useful way to engage with this mathematical content and with notions of change, at a deeper, affective level. Constructing timelines and discussing the order and sequencing of events in a plot to be scripted and/or performed (such as the journey of the tiny seed as it grows to become a plant), are activities that require the numerate concepts, skills, and dispositions of sequencing, reasoning and evaluating. Likewise, charting the stages of a narrative from orientation to complication to resolution is a key link between numeracy and drama and can be useful for exploring scenarios involving change or transformation. Settings may also be more complicated, such as the learners deciding how to distribute resources in order to best meet the needs of a community group or club. Each learner may be allocated a particular role in the drama, with certain needs and interests to be met. Coming to an equitable distribution of resources may require learners to consider issues of percentages, proportions and operations such as addition and division.

Conclusions

Described as 'an artform, a practical activity and an intellectual discipline' (Arts Council England, 2003: 4), drama provides a unique avenue for exploring and applying numeracy in the primary context. Notions of sequencing and ordering, estimation, measurement, spatial awareness and proportions are just some of the numerate skills and knowledge that may be explored through the content and processes of drama. Importantly, these numerate skills may be addressed in a highly imaginative, creative, fun and engaging manner, increasing the 'real world' relevance of mathematical instruction. Importantly, by providing a safe, supportive context for the acquisition and application of mathematical knowledge, drama has essential affective implications (The Arts Council of England, 2003). The creation of real and imagined worlds can allow for the exploration of mathematical concepts from a variety of social and cultural perspectives and allow for the extension of empathy and higher order thinking skills (ACARA, 2013; Edmiston, 2007; Roy, 2014; The Arts Council of England, 2003).

The Learning task: Drama: Foundation—Using Numeracy to Move

Students use body percussion and rhythm, spatial awareness and counting to make a soundscape to go with their story that perform as movement.

Differentiation: Students who demonstrate a strong understanding of soundscape could develop their own short skit that includes a story line and soundscape incorporated. Alternatively, they could read a picture book and identify parts where a sound scape could be included and they could ponder the effect the sound scape would have on the story, including if the beats were quick or slow. For examples of soundscape activities undertaken in the classroom access: https://www.youtube.com/watch?v=VOU5gAFV9v8 https://www.youtube.com/watch?v=N2QiCy8b_rk This activity was inspired by those found at: www.leics.gov.uk/subject_prompts.doc and https://dramateachersnetwork.wordpress.com/2011/11/08/numeracy-in-drama/.

Australian Curriculum Mathematics Outcome
(ACMNA001)

Numeracy Links

*Establish understanding of the language and processes of counting by naming numbers in sequences, initially to and from 20, moving from any starting point

**identifying the number words in sequence, backwards and forwards, and reasoning with the number sequences, establishing the language on which subsequent counting experiences can be built.

Australian Curriculum Subject outcome codes and indicators. *Outcome*: Explore role and dramatic action in dramatic play, improvisation and process drama (ACADRM027) *Descriptors*: Taking part in purposeful dramatic play focusing on experiencing the roles and situations they create. Taking turns in offering and accepting ideas, and staying in role in short improvisations. Exploring possibilities for role and situation when participating in whole group teacher-led process drama and roleplay. Taking photos or videoing drama they devise to view and extend their drama ideas.

Including ATSI perspectives: There are many traditional Aboriginal corroborees that rely on changes to beat to influence, for example, emotions, storytelling, and dancing. Show a corroboree video in the classroom, and have students clap the beat of the music (led by the didgeridoo), discussing the impact it has on their engagement with the music. This relates to the following outcome: Respond to drama and consider where and why people make drama, starting with Australian drama including drama of Aboriginal and Torres Strait Islander Peoples (ACADRR030).

Check with the local community to ensure this is conducted in a culturally appropriate manner, and consider inviting elders and/or community representatives to the classroom to showcase this form of storytelling through beats.

Strategies to include learners with oral backgrounds: Improvisation is a known strategy to engage students, who have formal English as an additional dialect or language, to participate in class activities. This activity is really well suited to students who rely considerably on performance and participation in order to learn effectively.

Authentic Assessment strategies

Film students performing their improvised soundscape. Play it to the students once with the audio visual and sound, and a second time with only the sound. Discuss with the students the difference it makes to just hear the sound scape, rather than be influenced by the images.

Variations for students from diverse social contexts:

Drama: Foundation—Using Numeracy to Move

Resources white/smart board, space to move and group together for the soundscape, audiovisual recording device, such as a video camera or tablet.

Implementation Strategies
Note: for this activity to be most effective, select a topic that the students have learnt about in class, and enjoy, for example, emotions, seasons, weather or physical environment such as: rainforests, oceans or an urban soundscape.

Part A: Improvisation through process drama

Teaching

- Introduce students to the concept of improvisation and soundscape (definitions in the Question prompts section).
- Explain to students that they are going to use their bodies and their voices to produce a soundscape on a set topic (the example of the beach is used for this lesson outline).
  - Brainstorm with students the types of sounds they hear at the beach (both natural and human contributions). Write on white/smart board. Examples could include: (i) Waves crashing on the beach (ii) Seagulls (iii) Running along the sand (iv) Eating ice-cream (v) Jet skis
- Teacher to lead an improvisation activity using process drama to have students sound out each sound from the brainstorm activity, using their bodies (e.g. clapping) and/or their voices.
- Select one sound (for example, waves) and discuss with students how the weather influences the speed and volume of the sound and the emotions these sounds may evoke. *Encourage students to count to 20 slowly, making the sound (clapping or stamping, for example) on each count; then speed up and continue to increase the counting from one to 20 until the students understand how varying the rhythm and beat can impact dramatic meaning.
- **Teacher to introduce counting backwards as a dramatic technique to create, for example, suspense, excitement or haste.
- This process is then repeated for the other sounds identified, with the teacher's role fading as the students gain a deeper understanding of the task.

The Learning Task: Drama: Year 1—A Caterpillar Comes to Dinner

This activity combines drama skills of rehearsal and presentation with numeracy skills of graphing and halving to develop a story of a caterpillar (from the book *A Very Hungry Caterpillar*) who comes to dinner.

Differentiation and similar strategies

A wide range of activities can be developed using other suitable books and similar strategies. They can be made simpler or increasingly complex depending on the class. For students who are particularly talented or interested in drama, encourage them to get together and develop a short skit that includes halves and to perform it to the rest of the class.

Australian Curriculum Mathematics Outcome

(ACMNA016)

(ACMSP263)

Elaborations:

Numeracy Links

*Understanding one-to-one correspondence describing displays by identifying categories with the greatest or least number of objects.

**Recognise and describe one-half as one of two equal parts of a whole.

***Sharing a collection of readily available materials into two equal portions splitting an object into two equal pieces and describing how the pieces are equal:
**Represent data with objects and drawings where one object or drawing represents one data value. Describe the displays.

Australian Curriculum Subject outcome codes and indicators

Outcome: Present drama that communicates ideas, including stories from their community, to an audience (ACADRM029) *Descriptors*:
Following cues and using voice and movement to link action, ideas and stories in their drama
Rehearsing and performing sequences of ideas to communicate stories through drama.

Including ATSI perspectives

In consultation with the local community, this activity could be adapted to include bush food and with a focus on an animal native to the local area, a story could be developed that follows the activity described in this lesson. All the class could then focus on sharing bush food with an Australian native animal.

Strategies to include learners with oral backgrounds

These activities are inclusive of the students' relative strengths in participation in performance that tells a story. The introduction of a text that relates to the oral presentation is a productive way in which to relate the oral and written texts meaningfully

Authentic Assessment strategies

The students, in their pairs, sit together to role play eating dinner together. Students to rehearse their role play, thinking about: what could they say to each other/questions to ask, related to the book? Start with the food between the two students. Teacher to instruct the students to divide the food in half and serve it out to each other. Teacher to observe that students are demonstrating their understanding of what a half is.

Variations for students from diverse social contexts

The topic of the drama activity and book may be interesting for some students who are familiar with butterflies as pests that eat the vegetable crops etc. in their gardens. Other students love butterflies for their colour and the way they 'dance' around in the air. There may even be discussion around why caterpillars eat so much and about their life cycle depending on the students in your class. It may be useful for the students to see a short youtube video about the life cycle of butterflies so they know more about caterpillars.

Part B: Using your body to move

- **Taking what has been learnt in Part A, the teacher now discusses with the students adding movement to their soundscape.
- **Using spatial language (for example, over, under, backwards, around, forward), the teacher directs movement to appropriately accompany the sound. As students understand how the process is occurring, the teacher relies more on the students' contributions, until they have reached the stage where the students are leading this part. Demonstrate to students the spatial language terminologies that will be used.
- **Students to demonstrate their understanding of this part of the activity by moving in response to the spatial language. This could then be extended to demonstrate number patterns by moving selected students away from the main group (through the use of spatial language).

Question prompts and example lines of inquiry
'Improvisation, or improv, is a form of live theatre in which the plot, characters and dialogue of a game, scene or story are made up in the moment. Often improvisers will take a suggestion from the audience, or draw on some other source of inspiration to get started'. Source: http://www.hideouttheatre.com/about/what-is-improv.

A soundscape is the '…"hear-able" elements of an environment…They are the sounds of a place, an event, an experience, or a life. Some of the elements are naturally occurring…the sounds of rainfall…Other elements are those that we choose to add to our environment—music, TV, conversation. **Each community, each place, each environment has a different soundscape**, depending on the sounds of the weather, the animals, and the people in that place at any given time'. Source: http://soundscapemusictherapy.com/what-is-a-soundscape-anyway/.

Drama: Year 1—A Caterpillar Comes to Dinner

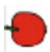
Resources Graph (on white board or on a large sheet of cardboard/butcher's paper); art and craft items such as paper plates, tissue paper, crepe paper, pencils, scissors, glue, paint, playdoh and other materials available in the classroom; materials to create props or masks.

Implementation Strategies
Note: This activity works well when combined with English lessons that focus on a book or other text currently being studied in class. The example used here is *The Very Hungry Caterpillar* by Eric Carle, however, any text that includes food, or

other item that is grouped, can be used. The activity should take place only after the students have read the book and are familiar with its contents.

Part A: Setting the Scene

- Teacher has a bag with the food that the caterpillar eats throughout the book, in the correct quantity. Teacher can photocopy the food items from the book or other source.
  - Sample available at: http://www.slideshare.net/andreagimenez/food-days-of-the-week-the-very-hungry-caterpillar
  - Pinterest also has a range of reproducible images (and ideas for classroom display)
- As a whole class group, one item from the bag is drawn out at a time (to maintain student interest, select a different student each time to do this). Then, the food item is placed on a graph that is either drawn on the white board or on a large sheet of cardboard/butcher's paper. For example, the graph will start to look like:
- Once finished, students to draw the graph in their Maths books, *counting each item and representing it as a number, rather than an image. Discuss with the students how graphs represent information and note what they are commonly used for. For example: to communicate numerical information in an easy-to-read format.

Apple	
Pear	
Plum	
Strawberry	
Orange	
Cake	
And so on until all the food items are included	

Differentiation and similar strategies

Audio visual fractional narrative examples:
https://www.youtube.com/watch?v=Rr9kN2fQYPw
https://www.youtube.com/watch?v=RYMD8SFreyI
The task can be varied to include any type of narrative that involves fraction problems. These can be simplified or made more complex depending on the student cohort and their competencies in partitioning and understanding the four characteristics of fractions. As an extra activity, particularly for gifted and talented students, have the students write their own narrative featuring fractions and invite groups to perform their narrative, demonstrating their understanding of fractions, to their peers.

Australian Curriculum Mathematics Outcome

(ACMNA058)

Numeracy Links

*Model and represent unit fractions including 1/2, 1/4, 1/3, 1/5 and their multiples to a complete whole

** partitioning areas, lengths and collections to create halves, thirds, quarters and fifths, such as folding the same sized sheets of paper to illustrate different unit fractions and comparing the number of parts with their sizes,

***locating unit fractions on a number line recognising that in English the term 'one third' is used (order: numerator, denominator) but that in other languages this concept may be expressed as 'three parts, one of them' (order: denominator, numerator), for example Japanese

Australian Curriculum Subject outcome codes and indicators

Explore ideas and narrative structures through roles and situations and use empathy in their own improvisations and devised drama (ACADRM031) exploring and experiencing a range of roles and situations that they initiate and develop.

The Learning Task: Drama: Drama: Year 3—Learning Fractions through Drama

The students have opportunities in this task to explore fractions through narrative and real life experiences.

Including ATSI perspectives

In many parts of Australia different tribes and groups of people did not traditionally use a base ten system, they used base five and equal sharing. It would be very productive tom invite a community member or parent to come and discuss or demonstrate other methods of equal sharing or partitioning

http://geckos.ceo.wa.edu.au/secondary/mathematics/Pages/number.aspx .

Strategies to include learners with oral backgrounds These activities are inclusive of the students' relative strengths in participation in performance that tells a story. The idea of an 'agony aunt' may be rather strange to them but working with others may help them develop the narrative required for this activity and perform it with their peers. This activity can be very powerful for the learning around fractions as much of the experiential learning they have known in other contexts may have had significantly different numeracy underpinnings. So that students can follow the narrative at their own pace, and to review it in order to successfully complete the activity, provide an audio visual of the fractional narrative that students are then to act out. This can either be pre-recorded by the teacher, or an example used from the popular site, You Tube. Examples are available in the *Additional resources* section.

Authentic Assessment strategies: In groups of four, students demonstrate their understanding of fractions by inventing their own "Agony Aunt" column and performing it in its entirety (not just the fractions), using mime. If appropriate, students could video tape their mimes to use as a learning tool for younger students. Scaffolding for students is available at: https://learnzillion.com/lesson_plans/8901-understand-fractions-create-mini-stories.

Variations for students from diverse social contexts

Historically, many different types of partitioning had been developed to meet the needs of people in different parts of the world. In some languages, there are no direct equivalents for the ways in which fractions are expressed in English. The metalanguage surrounding fraction work may also present difficulties for a range of students so it may be useful to develop explicit, reader friendly that explain the key terms, with the students and display these in the classroom. Fraction strips of the same length and in different colours for each fraction, provide a visual aid for all students so they can develop their narratives and 'see' some answers to their 'problems' themselves.

Part B: A Caterpillar Comes to Dinner

- Teacher to lead a discussion with the students about the types of food they like to eat for dinner, including their favourite dinner food. If time is available, the responses could be graphed in the same way as the caterpillar's food was graphed.
- In pairs, students role-play inviting the caterpillar to dinner. One student is the dinner host and the other is the caterpillar. Students to create a prop (or a mask) to show the difference between host and caterpillar. **The food is shared equally.
- Students are to think about creative ways to ask the caterpillar if he would like to come to dinner and the caterpillar replies. The teacher is to observe students and assist where required.
- ***Based on what the caterpillar and the host like to eat, plan a menu for the dinner and draw or create 3D representations of the food using art and craft items such as: paper plates, tissue paper, crepe paper, pencils, scissors, glue, paint, playdoh and other materials available in the classroom. Discuss and describe what can be seen on the displays.

Question prompts and example lines of inquiry
Students may need assistance with dividing by two (creating a half).

For students who are doing well with their dinner rehearsal, the teacher could instruct them to include the time for dinner (in Part B). This would meet the following Mathematics outcome: *Tell time to the half-hour (ACMMG020).*

Additional resources

http://www.slideshare.net/andreagimenez/food-days-of-the-week-the-very-hungry-caterpillar Inspiration for this activity is from one about the *Tiger who came to tea*, available at: https://www.tes.com/teaching-resource/tiger-who-came-to-tea-resources-6089764.

Drama: Year 3—Learning Fractions Through Drama

Resources Room for the students to move around in groups: either in the classroom, in the playground or a multipurpose centre (or similar), fractional narratives.

Implementation Strategies

NB: This lesson works best if techniques of mime have already been taught, or are being taught concurrently.

Part 1: Using mime to represent fractions

- Students to form groups of four.
- *Students divide themselves into teacher-stated fractions (as denominators and numerators). For example, the teacher may write on the board ½ or call out: 'half' or 'one over two' with students then moving themselves around to represent *half* in their group of four.
- *Teacher to ensure the Mathematics outcomes for this stage and year level are met by 'including 1/2, 1/4, 1/3, 1/5 and their multiples to a complete whole' (ACMNA058).
- *Once the students have become familiar with this drama activity and comfortable working together as a group, challenge the students to move into fractions using techniques of mime.

Part 2: Fraction Agony Aunt Narrative

- The teacher reads out an 'Agony Aunt' addressed to a 'Ms Fraction' newspaper advice column that includes a letter based on two fractions.
- An example is:

***Dear Ms. Fraction,*

I am at a new school and there are two classmates who would like to be my best friend: Larry and Harry.

Larry offered me 2/3 of his block of chocolate.

Harry offered me 2/5 of his block of chocolate.

I don't know what to do! Who do you think wants to be my best friend more, Larry or Harry?

From, Garry

Dear Garry,

I don't know who wants to be your best friend more, but I can tell you who is willing to give you more of their block of chocolate. Have your classmates help you find a common denominator of 1/3 and 1/5 and then act out the numerator to find who is offering you the most chocolate.

From, Ms. Fraction

- The teacher can also create their own 'Agony Aunt' letters or more are available at (where the example above is adapted): https://msdiazclass.wikispaces.com/file/view/Fractions+Funny+Stories.pdf.
- Students determine which fraction is the biggest, from two provided, using themselves as denominators and numerators. To do this, the teacher selects students to perform the fractions and the remainder of the classmates determine which fraction is the biggest.
- The teacher can assist the students to find the common denominator, as needed.
- **Map the fractions used on a number line and discuss what happens to the size of the fraction group as the denominator gets larger.
- Discuss this in terms of the reading and writing of the numerator and denominator.

Differentiation and similar strategies

For groups that find this task easy, in Part B have the students draw the grids in their notebooks (hidden from the participating student) and pencil in where the obstacles are, so that the participating student does not know and then undertake the activity, with oral commands. Students can then devise a penalty if the obstacle is disturbed. Or make other adjustments to the task that increases the complexity of the actions.

Australian Curriculum Mathematics Outcome

(ACMMG113)

Numeracy Links

*Use a grid reference system to describe locations.

**Describe routes using landmarks and directional language creating a grid reference system for the classroom and using it to locate objects

***describe routes from one object to another

Australian Curriculum Subject outcome codes and indicators

Explore dramatic action, empathy and space in improvisations, playbuilding and scripted drama to develop characters and situations (ACADRM035)

The Learning task: Drama: Year 5—Coding as Performance

Students use grids to develop instructional coding as part developing performance skills. Coding has become popular in recent times in schools and in emerging educational policies. This activity uses numerical ideas in coding for students to develop and create a skit they then perform in front of their peers. The use of their bodies encourages spatial awareness and is ideally suited to kinaesthetic learners (and teaching sessions after lunch!)

Including ATSI perspectives This activity could be adapted to meet the elaboration of the outcome, ACMMG113: comparing aerial views of Country, desert paintings and maps with grid references. Community members may be to advise the suitability of reproducing one of these images on the playground for use as a stage and the activity carried out on the playground or it may be possible to project a suitable image onto the classroom floor and have the class develop their coding on the surface.

Strategies to include learners with oral backgrounds

This activity is quite inclusive of these learners as it is planned for use orally and the repetition and the actions that accompany it are very supportive of the traditional ways of thinking and expressing new ideas in backgrounds of oracy. The language that is to be coded can be basic everyday positional language that is important and that is able to be demonstrated, not read from print.

Authentic Assessment strategies

Once the students have mastered the coding commands, students are to draft a skit with characters and a narrative and perform it (either as a class group or in smaller groups). There should be more than one character, so students will need to consider the complexity of moving within the grid space (and consider making the grid larger) when drafting the skit. Encourage students to use grid paper to draft the skit.

Variations for students from diverse social contexts

The considerations here are focussed on language use and the degree of sophistication in the actual language instructions, the tone and the ways in which the instructions are constructed. They may need to be very clear and direct for some students, to be delivered slowly enough for students to remember what they have to do, especially if they are processing from one language to another (code switching) and the instructions need to be given in small enough combinations so their partners do not attract penalties or are unable to actually complete them.

Question prompts and example lines of inquiry

- Once the students are familiar with and comfortable using their bodies to represent fractions, introduce an uneven number and have the students brainstorm and suggest ideas for how 'remainders' can be shown using miming or a drama technique.

Bringing it all together
The 'Agony Aunt' column could be replaced or complemented with a longer fractional narrative, examples available in the *Additional resources* section below.

Additional resources

This activity was developed from one available at: http://institute-of-progressive-education-and-learning.org/elearning/elearning-educational-entertainment/articles/.

Text-based fractional narrative examples: http://mathstory.com/algebrah/Algebrahindex.html#.Vmv1U7iGRBd.

Drama: Year 5—Coding as Performance

Resources Large space to move around, masking tape or similar, to create gridlines (chalk is great if undertaking this activity on concrete), everyday items as obstacles (for example, school bag, lunch box and pencil case), writing materials. *Note:* grids of 4×5 squares are a good starting point.

Implementation Strategies
Note: This activity takes place after preliminary information is provided to students about what coding is, including its uses. At its most basic, coding is an equation created to tell a computer program what to do. This audiovisual clip could be shown to students as an explanation: https://www.youtube.com/watch?v=THOEQ5soVpY.

Part A

- *Inform students that they will be developing a coding program and they will be using the (pre-drawn/marked) grid so that they can physically show what coding looks like.
- *Show students the grid on the floor and explain that they are to think of the grid as superimposed grid paper and that instead of using a pencil to mark out equations, they will use their bodies so that they can 'experience' the code taking place.
  - This activity works best if students are broken into small groups of around four, rather than as a whole class group. However, accessibility to floor or ground space will determine how and if smaller groups are created.
- **With the students, develop a simple coding language. For example: Move forward, straight ahead for one square could be commanded as: 'S1'; move forward, straight ahead for six squares could be: 'S6', turn left could be: 'TL'; turn right could be 'TR' and so on.
  - Students to write down these commands in their notebooks for reference when doing the activity.
  - Inform the students that the commands can be viewed as the rules of a game.
- ***Students are to instruct one selected student from their group to move, according to the commands, to get from the top left-hand grid (point A) to the bottom right-hand grid (point B) using only coding language to do so.

Part B

- ***Once students have mastered this, introduce the idea of obstacles for the students to move around and still get from point A to point B (these points do not always have to be from top to bottom and students can vary the distance between the two points). Students can gather nearby items (for example, pencil case, school bag and lunch box) and develop commands to instruct the student to move around.

Question prompts and example lines of inquiry
When students are having difficulty with the command, remind them to look at the commands that were developed as a group and to assist each other to work out a solution.

Bringing it all together
Part C

Additional resources

http://www.australiancurriculumlessons.com.au/2014/08/09/year-34-coding-lesson-plans-teach-kids-code/.

This activity was inspired by one found at: http://www.christhompson.info/mathsdrama2.html.

Differentiation and similar strategies

To extend student learning: Have students consider if there is a general equation that can be applied that disrupts the traditional linear sequence of a script but one that can still be followed, and makes sense to, the viewer. From here, have students develop an equation that can be applied to other scripts of a topical issue that show the script sequenced in a) a linear fashion and b) non-linear. Test out their theory with other students' scripts and revise as necessary.

Australian Curriculum Mathematics Outcome code and descriptors

(ACMNA179)

Numeracy Links

*Solve simple linear equations

**investigating a range of strategies to solve equations

Australian Curriculum Subject outcome codes and indicators

Combine the elements of drama in devised and scripted drama to explore and develop issues, ideas and themes (ACADRM040)

Descriptor: experimenting with linear and non-linear narrative to focus dramatic action and tension

The Learning task: Drama: Year 7—Numeracy in Drama through Sequencing

This task involves sequencing of an improvised and later scripted play on a topic issue. Students explore the differences between linear and non-linear sequencing of a play and the impact this has on the audience's understanding of the play and the topic being presented.

Including ATSI perspectives

This is one of the ways in which all students can authentically learn the discourses around the notion of story for these diverse groups of people. Tasks such as these can be sensitively enriched by the inclusion of community members and parents in the answers to the question- What does story mean to you? See: http://www.alea.edu.au/documents/item/775 for reflection and resources that promote intercultural knowledge and sensitivity

Strategies to include learners with oral backgrounds

The notion performance is really suitable for including these students. It may be an opportunity for these students to involve the class in the drama techniques that are used traditionally in their cultural setting to teach about new ideas and to reteach the traditions, customs and stories of their people. This would include techniques for exaggeration and drama on the part of the storyteller and audience response, physical activity and participation on the part of the audience. The actual writing of the script may have to be executed by drawing or using a scribe if necessary. The symbolic representation in linear and non linear may be quite accessible to these students because of the highly symbolic nature of their ceremonies and art forms.

Authentic Assessment strategies

To conclude this activity, students demonstrate their learning by writing an extended paragraph that explains how they used numeracy (sequencing, linear and non-linear equations) to inform their script, and the effect that changing sequencing had on the viewer's experience.
Students to consider how other techniques, such as lighting, could further influence the effect of the script on the audience.

Variations for students from diverse social contexts

Everyone has a story. Despite the diversity of students' backgrounds that can be found in any one classroom, this is the common thread. This task provides opportunities for students to understand the dramatic traditions of people from various parts of the world, engage respectfully with issues that affect students and presented as drama, either traditionally or in the context of the modern western techniques that are reflected in the syllabus. The equation that is required as part of the task can be accessed by all students, especially if the notion of symbolism is discussed thoroughly using the students own background knowledge and experience. The coding symbolism used by the students can be brought together as a mathematical equation by the use of mathematical notation and symbols. This is an opportunity to develop a diverse, respectful community of learners.

Drama: Year 7—Numeracy in Drama Through Sequencing

Resources writing materials (analogue or digital) to draft a script, space to perform.

Implementation Strategies
Note: This activity could potentially take place over a number of lessons, depending on how much detail the students write in their scripts, including techniques applicable for a stage production. Therefore, while this activity only focuses on the sequencing aspect of the lesson, the classroom teacher could make it broader by including other performance techniques (as described in the relevant curriculum documents).

- Teacher to introduce topical issue, or have students brainstorm a topical issue and decide in groups what to choose; for example *bullying*, or an issue in the broader community, for example, *racism*.
- In small groups, students first improvise this topic and perform it in front of their peers (or if time is an issue or the class is large, two groups could perform to each other).
  - It is expected that improvisation would have already been covered in the class.
- Each group receives feedback on their improvisation with a view to writing a script.
- *As a class group, the teacher discusses with students sequencing and how this relates to linear progression.
- Students, in their small groups, draft a script that builds on their improvisation.
- Once drafted, as a class group, the teacher then introduces the concept of nonlinear and how a play might not be sequenced as expected, but that it still makes sense to the audience.
  - Teacher can use the idea of *flashback* to emphasise this point: a play that might otherwise be linear has its sequence disrupted by one or more character having a memory, pertinent to the storyline, come back to them. Teacher to inform students of techniques to show flashback, for example, voice-overs, slow-motion acting, moving to a place on the stage that is reserved for flashbacks, or a combination of techniques.
- Students, in their small groups, review their scripts and undertake the following activities:
  - *Can an equation be applied to their script? For example, S1 (Scene 1) + S2 + S3 = CS4 (Complication Scene 4) + FS5 (Final Scene 5) = end of play.

  - *Then, they are to consider how they might introduce a nonlinear element to their play's current sequence and ensure that it still makes sense to the audience.

- As with the improvisation, have students perform it in front of their peers (or if time is an issue or the class is large, two groups could perform to each other).
- **Discuss how the nonlinear sequencing disrupts and/or enhances their understanding of the topic.

Question prompts and example lines of inquiry

- If students are having difficulty understanding sequence, show students/write on the whiteboard the Australian Curriculum: Drama definition of sequence:

  - 'The linking together of series of ideas, much like words are linked together to form sentences and paragraphs' (ACARA Drama, 2015: 20)

Bringing it all together

Additional resources

Inspiration for this activity was drawn from a Drama plan on www.english-teaching.co.uk.

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Pedagogical Approaches to Teaching and Learning English: Connections with Critical Numeracy

Rachel Burke, Heather Sharp and Caitlin Field

Introduction

Together with literacy, numeracy has been acknowledged as a foundation of formal schooling. Once considered the domain of the mathematics and English classrooms respectively, numeracy and literacy[1]—in all their forms—are increasingly recognised as important social practices pertinent to all subjects (Luke & Freebody, 1999, Steen, 2001, Unsworth, 2001, Watson, 2009, Goos, Geiger, & Dole, 2012). In the Australian Curriculum Assessment and Reporting Authority's [ACARA] (2015b), which lists skills required in order to 'live and work successfully in the twenty-first century', literacy and numeracy occupy prominent positions amid the seven general capabilities emphasised across all Key Learning Areas (KLAs). Increasingly, highly developed skills in multiple forms of literacies and numeracies are considered vital for citizens in the knowledge society. Booker (2011: 3) emphasises the importance of numerate and literate empowerment, noting that 'Individuals who lack an ability to think numerically will be disadvantaged, unable to participate in high-level work and at the mercy of other peoples' interpretation and manipulation of numbers… both literacy and numeracy are critical components for living productively in the 3rd millennium'. Cross-curricular integration of literacies and numeracies can

[1]We use the word 'literacy' in the singular here to reflect the terminology of ACARA policy, however, we employ the plural 'literacies' or 'multiliteracies' elsewhere in this chapter, as recognition of the multiple semiotic systems at play in communication.

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improve students' critical understanding across the two learning domains, and provide important opportunities for meaningful engagement with texts across a range of social settings.

Numeracy in the English Curriculum: Identifying Opportunities

The Australian Curriculum for English contains many opportunities for the exploration of numeracy in ways that are relevant and meaningful to the core content. A variety of connections to mathematical knowledge and skills are listed within the English curriculum's three 'strands', or conceptual frameworks for learning. Working in conjunction to facilitate well-rounded appreciation, comprehension, and critical composition of text, these three strands present a rich environment for the exploration of numeracy.

The 'Language' and 'Literacy' strands deal with issues of text construction. The 'Language' strand incorporates basic semiotic structures and patterns as well as advanced concepts of structural organisation, grammar and compositional choices (ACARA, 2015a: 9–10). Within this strand's emphasis on the functional aspects of language, there is extensive scope for developing numeracy skills and concepts. Students interrogate grammatical patterns and sequences, and consider spatial elements of print and screen text production such as formatting and layout (ACARA, 2015a, ACELA1450; ACARA, 2015a, ACELA1483). The 'Language' strand of the English curriculum (ACARA, 2015a) also identifies links to numeracy when students engage with multimodal texts that integrate mathematical components such as graphs and statistics (ACARA, 2015a, ACELA 1524). In the 'Literacy' strand, content descriptions starting at Year 1 indicate that students should be able to 'construct texts featuring print, visual and audio elements using software, including word processing programs' (ACARA, 2015a, ACELY1674), which suggests a need for understanding formatting and layout, margins, line spacing and indentation, and an awareness of effective placement of visual elements.

The Literature strand 'aims to engage students in the study of literary texts of personal, cultural, social and aesthetic value' (ACARA, 2015a: 10). Explicit numeracy skills included in the general capabilities for the strand include basic rhythm constructs and patterning in poetry (ACARA, 2015a, ACELT1452), but there are other more nuanced, but still imperative, connections with numerate concepts and repertoires. For example, the ability to develop 'personal responses to the ideas, characters, and viewpoints in a text' and 'understand how texts reflect the context of the culture and situation in which they are created' (ACARA, 2015a: 10), requires readers to effectively follow plot. This entails understanding concepts of sequencing and time, and may involve the ability to perform routine mathematical estimation regarding distance, quantity, money, etc. For students to critically understand text construction within different sociocultural contexts and time periods, they must also possess the ability to analyse alternative constructs of space, time and socioeconomics. This is particularly relevant when dealing with fantasy or science fiction texts that interrogate or recreate our concepts of time and space, such as in L'Engle's *A Wrinkle in Time* (1962).

There are many topics within the English curriculum that naturally incorporate important numeracy components that can be explored meaningfully without additional or onerous planning for teachers. Considering the role that numeracy plays in the ways students interact with texts can be useful for helping them establish meaningful connections. For example, interrogating rhythmic aspects of poetry and prose, using narratives as sources of data to graph information, and speculating on the probability of types of words (such as verbs) appearing in texts are all activities that can aid student understanding of texts, and can be conducted without specialised equipment and resources. The activities section of this chapter aims to provide some examples, linked directly to outcomes, of ways that teachers can meaningfully embed numeracy practices within English activities.

Numeracy in the English Curriculum: Exploring Connections

Shirley Brice Heath (1983) established that children's ideas and attitudes about literacy begin developing much earlier than when they first learn the alphabet, and that cultural approaches to engaging with texts can impact the way students perform literacy tasks all through their schooling. The same principles apply to students' mathematical development, with numeracy learning also occurring in the early years, before the formal process of schooling has begun (Booker, Bond, Sparrow, & Swan, 2014: 90). Teachers can acknowledge the numerate knowledge learners already possess when they enter formal schooling by integrating these social and cultural concepts and practices into the other core KLA of English.

This integration necessitates 'going beyond a view of mathematics as a decontextualized and sequenced set of skills' and requires educators to focus on asking 'questions about and valuing how children use mathematics in their everyday lives' (Sleter, 1997 in Guberman, 1999: 34). For example, Larson and Whitin (2010) discuss the use of graphs across the curriculum as a means of encouraging learners to engage with and communicate important mathematical relationships. They suggest a range of strategies for integrating numerate behaviours and graphical representations of data within the discussion of literature, such as conducting surveys around the questions: 'Which character would you like to be in (shared story)?' or 'Which of these three books would you like to read aloud first?' (Larson & Whitin, 2010: 19). Similarly, Watson and Neal (2012) draw meaningful connections between the Australian English and Mathematics curricula with regards to statistics and probability. Asserting that English and Mathematics are related through a mutual attention to 'context and critical thinking', Watson and Neal (2012: 97) make general links between the literacy strand of English and statistics through a focus on media texts (see also Watson, 2004).

The principle of integrated numeracy instruction applies to texts of all modalities:

> being numerate in English requires the ability to interpret and create information thoughtfully, accurately and critically when it is represented in spatial, numerical and graphic forms [and furthermore that numeracy occurs when] analysing quantitative and spatial information when it is presented in various forms, for example, shots in film, pacing of editing in multimedia texts and analysing use of space in advertising, graphs, tables, spreadsheets, charts and comparative models… (Victorian Department of Education, n.d.: 4)

Freebody and Luke's (1990) Four Resources of the Reader model provides a useful means of representing the skills, behaviours and attitudes required for this multimodal conceptualisation of numeracy. This framework has been adopted widely across Australian schools, and conceptualises literacies according to four roles of the reader/viewer/listener: code breaker, text participant, text user and text analyst (Freebody & Luke, 1990). The codebreaker repertoire refers to the skills and knowledge required to understand and link the relationship between individual letters, words or grammatical structures (coded information), and the sounds or images and meanings to which they correspond. The text participant repertoire includes skills and understandings required for applying background knowledge and cultural schema to create meaning from the decoded signs and images in the text. The third resource—the text user—relates to the knowledge of social and cultural uses of texts within particular situations, according to the purpose and intended audience. Finally, the text analyst role refers to critical engagement with texts across all modalities. These four roles or repertoires are required for rich, full engagement with texts (Freebody & Luke, 1990).

Brown and Hirst (2005) have applied Freebody and Luke's (1990) model to mathematics teaching, whilst Watson (2014) has reconceptualised the model to reflect the specific context of critical engagement with numeracy, maintaining the focus on critical engagement with text. Many educators suggest that functional knowledge and skills do not represent the totality of numerate expertise; rather, these skills must be accompanied by a critical understanding of mathematical texts and operations as part of broader social and ideologically situated communication (Kemp & Hogan, 2000, Steen, 2001, Watson, 2014, Brown & Hirst, 2005). Brown and Hirst (2005: 30) clarify, arguing 'mathematical literacy encompasses a critical stance—an awareness of the ways in which mathematics is used to generate particular kinds of meanings for particular purposes'.

Just as Freebody and Luke's (1990) text analyst resource refers to the knowledge and dispositions required to 'read between the lines' and identify embedded interests and intentions, Watson's (2014: np) Four Resource Critical Numeracy Model attends to the need for critical engagement with mathematical texts encouraging learners to ask questions such as 'What are the different ways numbers are used and represented?', 'What is this text about?', 'How would I use this text and what decisions would I make based on it?', 'Are the mathematical concepts used appropriately in this text?'. Freebody and Luke (1990) and Watson's (2014) frameworks allow teachers to deliberately plan for exploiting the opportunities for attention to numeracy that occur in the English curriculum. Incorporating the range of complex roles and resources required by fully numerate individuals allows the English classroom to become a place where rich, meaningful engagement with numeracy may occur.

The original Freebody and Luke (1990) model and Watson's (2014) critical numeracy framework complement each other in terms of charting the linguistic and numerate resources required for learners to engage with the content, and providing opportunities for scaffolding learner development in these areas. This is evident in a sample mini unit for foundation and year one focused on the story *Giraffes Can't Dance* by Giles Andreae (1999) (Australian Curriculum Lessons, 2013). This rhythmic text about a dancing giraffe contains various links to numerical concepts such as measurement, when describing Gerald's stature; even and odd numbers, when describing animal dance pairs; and language associated with shape, direction and prepositions of place when describing dance moves. The book can also be used to discuss sequencing and musical timing. Figure 1 presents various numerate behaviours, knowledge, skills and dispositions required for engagement with this text according to Freebody and Luke's (1990) model:

Watson and Neale (2012) have suggested the use of media texts as a starting point for critical and creative engagement with numeracy (see also Stack, Watson, Hindley, Samson, & Devlin, 2010). This is illustrated in Whitlin and Whitlin's (2003) example of cross-curricular numeracy, whereby primary aged learners developed critical numeracy skills through a unit of work on television advertisements. In graphing the various devices utilised across a range of television advertisements and plotting these against variables such as timeslot, product price and nutritional composition, the learners were able to utilise critical numeracy skills to hypothesise about the authors' intentions and the linguistic and stylistic devices employed to appeal to certain demographic groups. This critical attention to how

Code Breaker	Text Participant
• Specialist terms such as 'pairs', 'tall', 'crooked', 'circles' • Rhythm and sound patterns • Shapes and directions • Page numbering • Numerate operations such as measurement, estimation, and ordering • Numerate processes such as addition, subtraction, matching	• Building on existing knowledge of height and processes for measurement • Estimating the height of different animals in the story and in everyday life, e.g. pets, animals around the school, etc. • Activating background knowledge of pairs and socio-cultural notions of 'matching' and 'belonging'
Text User	**Text Analyst**
• Timeline for sequencing events in the plot • Shopping list for the jungle dance (ACARA, 2013) (understanding quantity and genre of text) • Recipe for cooking a cake for the giraffe (quantity and genre) • Instructions for a jungle dance based on Gerald's movements, e.g. "making circles on the ground" (directions, numbered steps, frequency of repetition) • Producing a graph showing different heights for animals in the story (ACARA, 2013)	• Counting frequency of adjectives or verbs used to construct participants – for e.g. words used to describe Gerald when he feels excluded and different • Writing the story from another character's perspective, for e.g. the cricket: Does he have a partner? Does he feel excluded? Identifying word choice and frequency to convey emotion and perspective. • Exploring notions of scale and thinking critically about representation, e.g. a mouse may seem large to a cricket but small to a person.

Fig. 1 Charting the various repertoires required for critically numerate engagement with the unit of work based on the text *Giraffes Can't Dance*. Adapted from and using original ideas from ACARA mini unit and plotted against Freebody and Luke's (1990) framework

mathematical concepts are utilised to persuade and manipulate the reader/listener/viewer provides an important opportunity for critical literacy and numeracy and fits closely with the text analyst repertoire of the Four Resources of the Reader (Freebody & Luke, 1990).

Conclusion

This chapter has identified the importance of meaningfully integrating critical numeracy in English. While primary school teachers are adept at integrating content across the curriculum, there is a paucity of resources that meaningfully and explicitly address numeracy within English content. This may be a consequence of traditional views of literacy and numeracy as diametrically opposed to each other. The activities in this chapter aim to provide an entry point for teachers to feel more comfortable and confident when addressing numeracy as a key component of English. In doing so, it is anticipated that those students (and teachers!) who claim they are 'not good at maths' will see that developing numeracy skills through the English KLA can and should occur seamlessly and as part of everyday classroom learning tasks.

Differentiation Create a spelling list from the animals nominated by the students. Allocate set words to students depending on their current ability in written English literacy. This meets the outcome: ENe-54: Demonstrates developing skills in using letters, simple sound blends and some sight words to represent known words when spelling.	**Australian Curriculum Mathematics: Outcomes and Elaborations:** ACMNA002: Connect number names, numerals and quantities, including zero, initially up to 10 and then beyond*	**Numeracy Links:** * Estimating and calculating with whole numbers: Understand and use numbers in context
Australian Curriculum Subject outcomes and descriptors **Outcome:** Recognise and generate rhyming words, alliteration patterns, syllables and sounds (phonemes) in spoken words (ACELA1439) **Elaborations:** identifying patterns of alliteration in spoken words, for example 'helpful Henry'	**The Learning task** **Foundation: Animal Alliteration** This task requires students to use the literary device of alliteration combined with the numeracy skill of addition by playing a game with dice and flash cards on a theme currently being studied in class. Skills and knowledge used in this lesson include: plural forms, alliteration, spelling (optional), visual literacy (symbols on dice, numerals, pictures of the animals), and addition.	**Including ATSI perspectives** Acknowledging important cultural relationships with the Land and sharing with the class.
Strategies to include learners with backgrounds of oracy: These students may find symbolic representation as numbers easy to work with at first as it is part of their background, also the learning is embedded in narrative which is perfect for this groups ways of making meaning. Some students may have the advantage of seeing these animals in the wild and this will support the new conceptual ways of thinking about measurement etc. Good activity (when used with concrete materials) for promoting one to one correspondence.	**Authentic Assessment strategies:** To finish the activity, in groups students produce a story book that includes the numbers from 1-12, each on separate pages with the animal alliteration illustrated that was nominated after each roll of the dice. Students publish their book (either word processed or hand written and illustrated) and share it with their peers. It can also be used as a home reader.	**Variations for students from diverse backgrounds** For many students who have backgrounds of limited linguistic capital, or restricted codes, this is a good opportunity for them to learn to 'play' with sounds and words and to enrich their vocabularies

English: Foundation-Animal Alliteration

Resources Dice (x2), smart/white board and individual flash card sets for (i) pictures of animals, (ii) names of animals (optional), (iii) numerals and (iv) words for numerals (optional).

Implementation Strategies
Part 1: Revision

- This activity works well to revise and reinforce relevant vocabulary (in this case the theme is 'animals' but any pertinent lexical set may be used), the decoding of numerals as symbols and as words (optional), and addition skills.
- It may be helpful to review this knowledge prior to the activity, activating student background schema by encouraging descriptions of each type of animal, recounting where they have seen each animal etc.
- Encouraging students to sound out words and talk about the 'matching sounds' e.g. the phonemes in 'fish' and 'five', 'two' and 'turtle', etc., can draw attention to alliteration.

Part 2: Orientation

- Set the scene by establishing an imagined scenario such as going on a bush walk, a day at the beach or night expedition.
- Begin with a set phrase to be repeated throughout the activity for example: 'We went for a bushwalk and guess what we saw?' Encourage students to think about what they might see on a bushwalk.

Part 3: Playing the Game

- The teacher models rolling the dice and encourages students to identify the numbers shown and add these together.*
- If both dice show the number one, the teacher then asks the students to add these together and then identify an animal name that starts with the 't' sound*. The students can then select the flash card for '2' (and/or 'two') and a picture of the animal (and/or the corresponding word).*
- After the dice have been rolled a number of times, the smart/white board may look like this:

2. tigers
3. thunderbirds
4. frogs
5. flying foxes

Differentiation For students that are struggling to understand the concept of syllables and therefore how many syllables are in individual words, provide them with a haiku template, partly filled in, with one word blank from each line and a selection of words (all with the same number of syllables) to select from. Then, provide more sample haikus, slowly taking away the scaffold of words to select from, clapping the beat/number of syllables with the students until they are able to complete independently.	**Australian Curriculum Mathematics Outcomes and Elaborations:** ACMNA015: Represent and solve simple addition and subtraction problems using a range of strategies including counting on, partitioning and rearranging parts* ACMNA030: Use a range of efficient mental strategies for	**Numeracy Links:** * Estimating and calculating with whole numbers: Estimate and calculate ** Estimating and calculating with whole numbers: Understand and use numbers in context, estimate and calculate
Australian Curriculum Subject outcomes and descriptors **Outcomes:** Listen to, recite and perform poems, chants, rhymes and songs, imitating and inventing sound patterns including alliteration and rhyme (ACELT1585) Elaborations: listening to and performing simple haiku poems about familiar topics such as nature and the seasons.	**The Learning task** **Year One Counting Syllables, Creating a Haiku.** In this lesson, students use the numeracy skill of counting to identify syllables in words, so that they can then write a haiku poem based on a predetermined number of syllables. This is an activity based lesson, with clapping encouraged so that students can identify syllables.	**Including ATSI perspectives** Consider poems and poetic techniques that Aboriginal and Torres Strait Islanders use in their traditional cultures to clap a rhythm and identify syllables in words. Do with whole class
Strategies to include learners with backgrounds of oracy This language lesson is structured perfectly to support the ways of knowing that are culturally and traditionally matched with these students' cognitive strengths. The major creative works of many people who have backgrounds of oracy is storytelling and poetry.	**Authentic Assessment strategies:** Traditionally, haikus are also illustrated. When students have their completed haikus, they are to write them onto a foldout card (this can be made with art paper), they are to write the haiku on the inside right hand side page and illustrate the front of the card. They are then to send the card to someone. This can be someone in the class, in the school, or someone of their choice. The teacher may encourage students to think of someone who has done something nice for another person and to send the card as a 'thank you'..	**Variations for students from diverse backgrounds** Some students may not be very familiar with poetry and its structures, even in the most basic forms as nursery rhymes so there may be a need to explore the notion of poetry and compare to other written text forms or genre so that the students have a good understanding of structure, purpose and audience. Some students may find this form of poetry very familiar and are able to tap into ts cultural background from experience.

6. snakes
7. starfish
8. echidnas
9. numbats
10. turtles
11. eagles
12. tweeting birds

As each student has a chance to roll the dice and place the flash cards on the board, repeat the phrase as a class 'We went for a bush walk and guess what we saw? Two turtles, four flying foxes, nine numbats…' adding new animals after each turn.

Question Prompts and Example Lines of Inquiry
For students who experience difficulty with alliteration (even after explanation), give them up to three options of animals for them to select from; only one correct. For example, for the number six, the teacher could give the option of *snake*, *monkey* and *turtle*, encouraging the student to listen to the words carefully and with the teacher exaggerating the sound to provide clues for the student.

English: Year 1—Counting Syllables, Creating a Haiku

Resources Writing materials, word list (either the week's spelling list or theme list; winter has been selected for this example), syllable table (students can draw one themselves, or teacher can provide it on an activity sheet) and magazines to cut out words (optional).

Implementation Strategies
Part 1: Counting Syllables
For students to be able to write their own Haiku poems, they need to understand syllables and how words can be broken down into syllables.

- Students first identify syllables in selected words (either from a spelling or theme list; or teachers may ask students to find their own words from a selection of provided texts, for example, magazines).
- Write the words onto a table (like the one below). An alternative is for students to cut words out of magazines/newspapers.
- Students then divided the word into its separate syllables, one for each table column.**
- Write into a table that has the syllabus separated and then a column so that students can write the number of syllables that each word contains.
- As a class group, or in small table groupings, teacher to assist students to clap out each syllable, so that they can hear and experience the breaks in the word.

Word	Syllable 1	Syllable 2	Syllable 3	Number of Syllables
Winter	Win	ter		2
Snow	Snow			1
Igloo	Ig	loo		2
Umbrella	Um	brel	la	3

Part 2: Creating a Haiku

Explain that a haiku is a traditional Japanese poem that is frequently on the topic of nature or seasons and it focuses on small/fine details. For example, describing a snowflake, rather than the larger topic of winter.

- Students listen to teacher reading of a selection of haiku poems. Two sample haikus include:

Being Cold

Icy tips on hands
make it difficult to count
coins from my wallet
source: http://hubpages.com/literature/Haiku-poems-about-winter

Cloud Dust by Writer Fox

Clouds shake white dust down –
All the trees turned to snowmen,
The eyes made of ice.
Source: http://hubpages.com/literature/The-Winter-Poems

Clap out each syllable for each individual line of the haiku. Identify that a haiku poem has a set syllable count: First line: 5 syllables, Second line: 7 syllables and Third line: 5 syllables*.

- Students to write their own haiku on the provided topic (or, free choice)
- Students to identify each syllable by either lightly colouring each syllable a different colour, or by circling**. They can check their work to ensure they have

the required number of syllables for each line. Share with a peer and to check the syllable count.

Question prompts and example lines of inquiry:

When students are having difficulty remembering how to count syllables, or what a syllable is, assist them by clapping out the word; which also assists students to identify rhythm.

Additional Resources

Winter haiku poems:

http://hubpages.com/literature/Haiku-poems-about-winter http://hubpages.com/literature/The-Winter-Poems http://www.readwritethink.org/classroom-resources/printouts/haiku-starter-30697.html.

http://www.kidzone.ws/poetry/haiku.htm.

http://www.scholastic.com/teachers/article/five-creative-ways-teach-haiku.

Differentiation

Adapt student learning, by having students wrap their own selection of gifts (from objects found around the classroom) and working in small groups of approximately four peers to imitate the questioning and guessing that occurred in the whole class activity. Students can create a table to record their guesses and their reasons.

Australian Curriculum Mathematics Outcomes and Elaborations:

ACMM037: Compare and order several shapes and objects based on length, area, volume and capacity using appropriate uniform informal units*

Compare lengths using finger length, hand span or a piece of

Numeracy Links:

* Using measurement: Estimate and measure with metric units

** Using measurement: Estimate and measure with metric units

Australian Curriculum Subject outcomes and descriptors

Outcome:
Construct texts that incorporate supporting images using software including word processing programs (ACELY1664)
Elaborations: adding images to digital written communications such as emails with pictures of self, classmates or location
Outcome:
Use interaction skills including turn-taking, recognising the contributions of others, speaking clearly and using appropriate volume and pace (ACELY1788)
Elaborations: participating in pair, group and class speaking and listening situations, including informal conversations and class discussions, contributing ideas and listening to the contributions of others

The Learning task

Year Two: Sorting Presents

For this activity, students consider shape, size and weight to match wrapped presents to a present/gift list. They record their findings in a table. They send an email, with an attached photo, as a thank you to the fictional character. Skills and knowledge used in this lesson include: visual literacy, vocabulary for the gifts and characters' names, problem solving skills, concepts of shape, colour, size, and weight and descriptive vocabulary

Including ATSI perspectives: It appears that, long before colonisation, many Aboriginal groups had customary given and received objects as gifts. These may have been with people outside of their own tribe or mob, or may have been part of formal ceremonies, rites of passage etc. most students today would have some knowledge with the idea of gift giving and receiving.

Strategies to include learners with backgrounds of oracy: Like the ATSI students, many of these students would be familiar with cultural notions of giving and receiving gifts, at least on ceremonial occasions. Some students may have no personal experience of gift giving and receiving but are very competent in estimating and working with the concrete nature of shape size and weight. The technological aspect of creating and sending an email may be challenging, however, this activity lends itself well to being developed as a narrative within which to embed the learning.

Authentic Assessment strategies Select students to unwrap a gift, so that the class can see if their hypothesis was correct.
Students to pretend they received one of the gifts and write a thank you email to the character, describing the features of the gift (using numeracy vocabulary) and why they appreciate it.
Students to add photos of peers with the presents to the email that they have taken with a digital camera (teacher to provide their own professional email address for students to send the email)

Variations for students from diverse backgrounds.

It may be appropriate to talk to students about the types of gifts they might like to give and receive rather than what they have received. Some groups or communities in Australia do not celebrate some of the most common gifting times such as birthdays, Christmas or other celebrations. In that case, the context would have to be considered carefully.

English: Year 2—Sorting Presents

Resources Gift list containing characters' names and presents, (names and vocabulary can be taken from a relevant book or unit of work), items of varying weight and shape, wrapping paper of different colours or patterns and gift cards or tags.

Implementation Strategies
Part 1: Setting the Scene

- The teacher sets the scene, explaining that a character from a relevant book (one that is being used in the classroom) has purchased or made presents for their friends.
- Have a present/gift list on the smart/white board and revisit the vocabulary, encouraging students to describe the attributes of each gift, 'A pencil holder would probably be square and light'.
- Discuss whether the students themselves would like to receive this gift or if they have made or purchased something similar for a friend.

Part 2: Missing gift tags

- Next, the teacher can explain that the main character has carefully wrapped each gift in specially selected paper, but unfortunately, the gift tags or cards have fallen off.
- Encourage students to speculate how they could identify each gift without unwrapping it, explaining that their knowledge of weight, shape and size will help.

Differentiation

Variations to the activity could include having students think up (with teacher assistance) equations in which they can write their *Prose Snowball*. For example: multiply by 2; making the first line 2 x 1, the second line 2 x 2, then 2 x 3 and so on. Explain why it is called a prose snowball at all! Occasionally, students are permitted to crunch these up and have a gentle snowball fight in class!

Australian Curriculum Mathematics Outcomes and Elaborations:
ACMNA060: Describe, continue, and create number patterns resulting from performing addition or subtraction*

Describe a rule for a number pattern, then creating the pattern**

Numeracy Links:

*Recognising and using patterns and relationships: Recognise and use patterns and relationships

**Recognising and using patterns and relationships: Recognise and use patterns and relationships

Australian Curriculum Subject outcomes and descriptors

Outcomes:
ACELT1606: Understand, interpret and experiment with a range of devices and deliberate word play in poetry and other literary texts, for example nonsense words, spoonerisms, neologisms and puns (ACELT1606)

Elaborations
defining spoonerisms, neologisms and puns and exploring how they are used by authors to create a sense of freshness, originality and playfulness discussing poetic language, including unusual adjectival use and how it engages us emotionally and brings to life the poet's subject matter, for example 'He grasps the crag with crooked hands' (Alfred, Lord Tennyson); 'Wee ... tim'rous beastie' (Robert Burns)

The Learning task

Year Three: Summer in Australia: Prose Snowball.
Prose Snowball provides students with the opportunity to use their numeracy and creative writing skills to compose a poem that is both interesting and follows principles of numeracy, for example, counting by one, making a growing pattern.

Including ATSI perspectives

For visual and kinaesthetic learners, use a stimulus material that they can select from a box/bag to help them find a topic. For example, for the theme *Summer in Australia*, a resource bag could be filled with summer items such as: a beach ball, a pair of thongs, sunscreen, a hat, and photos of events/outings/weather situations that commonly occur during summer.

Strategies to include learners with backgrounds of oracy

Written text is challenging for these students but this activity, which engages in the narrative without the structures and grammatical conventions is an ideal means by which students can express their own experiences or learning as a narrative.

Authentic Assessment strategies

Students to read out loud to their peers (as a whole class group) their completed *Prose Snowballs*.

Students to write their *Prose Snowball* out with an explanation of the numeracy links (1-2 sentences is sufficient). Display Prose Snowballs around the classroom.

Variations for students from diverse backgrounds

The students may have had the experience of making handing and throwing a snowball, however, a number of the group may not so that places them at a disadvantage unless appropriate introductory materials are used. Some students may need to hold ice cubes or the cold pack from the freezer to try and anticipate the feelings of extreme cold. Look at: https://www.youtube.com/watch?v=v4HgqVhzfps

- It can be useful to have each gift wrapped in a particular colour of paper so that students can easily identify each item in order to discuss its relative characteristics, e.g. 'The blue present is too heavy to be a pencil holder' or 'The orange gift is too small to be a hat'.

Part 3: Sorting the Gifts

- Encourage students to hold each wrapped present, speculating as to which item on the gift list it may be, then pass it along so that all students get a turn of feeling for attributes, hefting and hypothesising and reasoning.*
- They also need to use informal measures to measure the gifts and the palms of their hands (and the hands of their group or partners) to discuss the area that the parcel covers in relation to the palms of their hands.**
- When each student has had a chance to guess the nature of each gift, have the students record their answers by writing the colour of the present beside the corresponding gift item with a reason for their guess, e.g. 'It has hard, pointy edges' or 'It is light and round'.*
- Students can draw a two column table; writing in the left column what they think the present might be; and in the right column what the present actually was when it was unwrapped.*

Question prompts and example lines of inquiry

- For Part 3, for students who find it difficult to hypothesise, use guiding questions such as 'What shape is this gift?' and 'Could this be a book?'
- Some children may need scribes or may have no idea what sorts of things could be in the presents.
- Teachers may be able to guide these students in a micro teach situation while the others are passing the parcels around to determine their attributes.
- It may be a good idea to have a small number of gifts reserved for this group of students only so that they have more time to hold and to consider their hypotheses.

English: Year 3—Summer in Australia: Prose Snowball

Resources White/blackboard, paper, writing materials and resource bag with themed items (optional).

Implementation Strategies

- British teacher Alan Gillespie has written perhaps the most frequently used example Prose Snowball, looking at the topic: *Cold*. His example is as follows:

1. Cold.
2. Numb fingers.
3. My breath freezes.
4. Can't feel my toes.
5. I have sent for help.
6. Please God, when will it come?
7. I have done nothing to deserve this.
8. Stuck out here in the wind and snow.
9. And so on…

- Inform students they will be writing a poem on the topic currently being studied in class. For the purposes of this example, the topic 'Summer in Australia' has been selected.
- To write the poem, start with one word, for example, 'Beach'.
- The next line contains two words, for example 'Hot sand'.
- Each line following contains one more word than the line before.* For example, the third line could be: 'Waves crashing down'; the fourth line could be: 'Swimming in the water'; the fifth line could be: 'Hoping not to get sunburnt'; the sixth line could be: 'I should put on more sunscreen' and so on until ten lines, or however long the teacher determines.
- Elicit student responses, but only record them if they fit the pattern. As students to describe the pattern.**

- Encourage students to follow a narrative structure when writing their *Prose Snowball*, so that a storyline is followed, rather than a random collection of sentences.**

Question prompts and example lines of inquiry:

- Make it more complicated by insisting students use alliteration or onomatopoeia in various (identified) lines of the prose (alliteration and onomatopoeia are covered in the Year 3 outcomes and while students should be familiar with these concepts, they may require a reminder). Alternately, have students develop (in groups) new rules for a *Prose Snowball* that uses a different pattern (i.e. two words are added each time).**

Bringing it all together:
Additional Resources:
This activity was modified from one found at: Gillespie, A. (January 16, 2013). *Where couplets meet calculations: combining maths and poetry in class*. Retrieved from: http://www.theguardian.com/teacher-network/teacher-blog/2013/jan/16/teaching-maths-poetry-oulipo-classroom.

Differentiation

Extend learning by having students write the instructions, with no further verbal explanation or clarification about where to find the treasure. This will require students to consider the need for clarity in their instructions and how their writing choices impact the reader. Students need to closely follow the procedural text type.

Australian Curriculum Mathematics Outcomes and Elaborations:
ACMMG090: Use simple scales, legends and directions to interpret information contained in basic maps*

Use directions to find features on a map**

Numeracy Links:

*Using spatial reasoning: Interpret maps and diagrams

** Using spatial reasoning: Interpret maps and diagrams

Australian Curriculum Subject outcomes and descriptors

Outcome: Use interaction skills, including active listening behaviours and communicate in a clear, coherent manner using a variety of everyday and learned vocabulary and appropriate tone, pace, pitch and volume (ACELY1792)
Elaborations: listening actively including listening for specific information, recognising the value of others' contributions and responding through comments, recounts and summaries of information
Outcome: Understand that paragraphs are a key organisational feature of written texts (ACELA1479)
Elaborations: noticing how longer texts are organised into paragraphs, each beginning with a topic sentence/paragraph opener which predicts how the paragraph will develop and is then elaborated in various ways

The Learning task

Year Four: Finding Treasure

This activity provides students with the opportunity to create a treasure map from a template provided and to guide a peer to locate the 'treasure'. Skills and knowledge used in this lesson include: vocabulary, visual literacy, spatial awareness, directions such as left, right, prepositions of place for example, "on top of the flowers", "beside the palm tree", estimating distance, for example "Approximately one centimetre above the shore", procedural genre: imperatives, ellipsis for example, "Turn left from palm tree", sequencing markers 'next', 'now'.

Including ATSI perspectives

Instead of undertaking this activity on grid paper, create a grid in the school playground (using rope, string, objects or other suitable material) to delineate the grid lines and have students read out instructions to locate the treasure from a prepared text. Many students would find this helpful and enjoyable

Strategies to include learners with backgrounds of oracy

These students may not be challenged by the oral parts of this task but the written procedure may prove to be more challenging. Like the ATSI students, many of the students in this group like to actually engage in activity, to construct and destruct using the oral language required but they will have traditional methods of mapping and planning that do not include written instruction. These can explored.

Authentic Assessment strategies
To conclude this activity, students are to consider how it felt to communicate with a peer without being able to see face expressions. They are to write a short text (a paragraph is sufficient) indicating the benefits and drawbacks from only hearing an oral explanation.

Variations for students from diverse backgrounds

Most students will enjoy this type of activity but students with restricted codes or little English may have to practice with their partner so that the absence of non- verbal features do not detract excessively from their capacity to participate effectively

English: Year Four—Island Adventure

Resources Island map template drawn on grid paper (two per student) marked with a 'starting place', list of landmarks to be drawn onto the map (vocabulary can be taken from a relevant book or unit of work and can be related to key mathematical concepts), cardboard cut-out of 'treasure' (this could be a rare flower or an endangered species of animal—whatever is most relevant for the students) with double-sided tape to be placed somewhere on the island, folders to create a barrier (optional as students can sit back to back as an alternative).

Implementation Strategies

Part 1: Illustrating the island

- Distribute the island map (photocopied on grid paper).
- Students to illustrate the island template with pictures of the landmarks listed on the white/smart board and/or on the island map (as a key).*
- The teacher or another student can also read out the landmarks to introduce a listening component to this stage of the activity.
- Encourage students to be creative when deciding where to locate each landmark, for instance, placing the 'spherical pebbles' at the bottom of the lagoon or the 'three giant starfish' in a triangle formation on the shore.
- Finally, students place the 'treasure' cut out somewhere on their islands. Remind students that the location of the treasure is a secret!

Part 2: Guiding a friend to the treasure

- Depending on teacher's preference, students can either write a list of directions to the treasure following the genre of a procedural text (see differentiation for this activity), or students may produce spontaneous, oral procedural texts to guide their partner to the treasure.**
- Ensure students begin their instructions from the set 'starting place' marked on the island template. Students will need to sit back to back or have a barrier (such as a folder) between them as they describe the various landmarks and give directions as to how to find the treasure, for instance 'To the left of the starting point there are four spherical pebbles. Approximately two centimetres above these pebbles, there is a large palm tree. Go to the top of the tree and turn right'.**
- As the student hears the directions, s/he draws in the landmarks on the blank map, aiming to replicate their partner's island as closely as possible. Finally, s/he pinpoints where the treasure lies and then the two students compare their maps.*

Differentiation

To extend learning, have students plot other narratives currently being used in the classroom on the same graph (using different colours). With assistance, students can then identify where the most interesting/exciting point in the narratives occur and draw conclusions about how the authors' intended complications/climaxes correspond with their idea (as the reader) of the most exciting part of the narrative.

Australian Curriculum Mathematics Outcomes and Elaborations:

ACMSP118: Pose questions and collect categorical or numerical data by observation or survey*

Numeracy Links:

***Interpreting statistical information:** Interpret data displays

Australian Curriculum Subject outcomes and descriptors

Outcomes:
Identify, describe, and discuss similarities and differences between texts, including those by the same author or illustrator, and evaluate characteristics that define an author's individual style. (ACELT1616)

Elaborations:
exploring two or more texts by the same author, drawing out the similarities, for example subject or theme, characterisation, text structure, plot development, tone, vocabulary, sense of voice, narrative point of view, favoured grammatical structures and visual techniques in sophisticated picture books

The Learning task

Year Five: Plotting a complication: Using graphs to identify narrative structures.

Students summarise texts by plotting, on a graph, the main points of the narrative. Specific attention is paid to plotting the complication so that a compare and contrast can take place across texts and with other peers noting at what stage in the narrative the most and least exciting/interesting parts occur.

Including ATSI perspectives

Consider the structure of traditional stories of the local area and plot these on a graph. Students can undertake a compare and contrast to see if the plot complication parallels that of non-Indigenous narratives. This is an activity for all the class.

Strategies to include learners with backgrounds of oracy: If implemented using the oral narratives that are the keystone of these cultures, the learning outcomes for these students could be very successfully achieved. Like ATSI students, the history and lessons learned by this group was handed down as oral narrative so this genre would be familiar to the students and would suit their traditional ways of knowing.

Authentic Assessment strategies

The products will provide evidence in terms of the learning. In addition, at the completion of the activity, students can write out the most popular ending for the story (according to the short story text type) and then compare this with the real (that is, author's) conclusion.

Variations for students from diverse backgrounds:

Even though students may have experienced many years of schooling, a wide range of obstacles may have impacted on their learning and this activity lends itself easily to engaging with stories told at home with family that reflect social and cultural differences. Students can use these stories just as easily to explore what else could have happened in the end and to share with partner or small groups so that the interactions supports an understanding of student diversity in the class

Question prompts and example lines of inquiry
Students are encouraged to ask for clarification of instructions, asking their peer: 'could you repeat that please?'

This activity works best when done in conjunction with a series of lessons on directions and the procedural genre. Without the paralinguistics of gestures and facial expressions, the task relies on language to work. The teacher may increase the listening component by deciding that students cannot repeat their instructions!

English: Year Five—Story Survey

Resources Extract from a relevant book or short story (provide only up until a pivotal point in the plot), response sheet for recording student thinking and answers.

Implementation Strategies
Part 1: Starting the Story

- Provide students with the extract and read the first part of the text, discussing the evolving plot and character traits.
  - It is helpful to select a text that has a pivotal moment within the plot and only provide this part of the story, so that students can speculate about possible ways the narrative may unfold.
- Encourage students to consider the plot from the perspective of each of the characters, and suggest potential story endings, based on their knowledge of similar texts, key information in the story, etc. Write responses on the white/smart board.

Part 2: Constructing a Survey

- Once possible story endings have been considered, suggest the idea of surveying classmates to find out the most popular conclusion. The teacher can activate students' background knowledge regarding surveys—e.g. purpose, schematic structure, language features, etc.—and facilitate a class discussion of sampling.
- When determining who to ask to participate in the survey, teachers will need to ensure that students are aware of ways of increasing the accuracy and reliability of survey results. After exploring the different types of surveys (for example, multiple choice and short answer), students can discuss the relative merits of each and then select a style best suited to their purpose (they can be different from student to student). In groups, students can then decide on which possible endings they wish to survey (encourage humorous and creative possibilities) and turn these into short questions or statements depending on the style of survey chosen.*

Differentiation

In small groups, especially targeted for kinaesthetic learners, have students act out the final story ending to their peers. Other ideas for differentiation include acting out an alternative ending, drawing the final ending or making a soundtrack with music or sound effects to accompany the story as they read it aloud.

Australian Curriculum Mathematics Outcomes and Elaborations:

ACMSP147: Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables*

Compare different student-generated diagrams, tables and graphs, describing their similarities and differences and commenting on the usefulness of each representation for interpreting the data**

Numeracy Links:

*Interpreting statistical information: Interpret data displays

** Interpreting statistical information: Interpret data displays

Australian Curriculum Subject outcomes

Outcome: Recognise that ideas in literary texts can be conveyed from different viewpoints, which can lead to different kinds of interpretations and responses (ACELT1610)
Elaborations: examining texts written from different narrative points of view and discussing what information the audience can access, how this impacts on the audience's sympathies, and why an author might choose a particular narrative point of view
Outcome: Create literary texts that experiment with structures, ideas and stylistic features of selected authors (ACELT1798)
Elaborations: drawing upon fiction elements in a range of model texts - for example main idea, characterisation, setting (time and place), narrative point of view; and devices, for example figurative language (simile, metaphor, personification), as well as non-verbal conventions in digital and screen texts- in order to experiment with new, creative ways of communicating ideas, experiences and stories in literary texts

The Learning task

Year Six: Story Survey

This activity is an opportunity for students to be creative and make predictions about story endings. Using information from a provided extract, they survey their peers for the most creative ending and then, using the text type of a short story, they write the ending before comparing with the author's original version. Skills and knowledge used in this lesson include: print literacy, problem solving skills, survey text features, and concepts of sampling and data.

Including ATSI perspectives: Students cannot effectively develop alternative endings to their traditional stories as this would be considered inappropriate and not permitted – it breaches protocols to ask students to engage with such a task. However, they may enjoy selecting one of the alternative ways in which to demonstrate the story ending of the story that was the focus of the class survey.

Strategies to include learners with backgrounds of oracy.

Culturally, these students have strengths in cognitive process that respond to animated narrative, repetition and responses, interactions such as clapping, singing and movement in response to the similar stimulations provided by the story teller. In these cultures, storytelling and poetry are the major art forms. These students may be prepared to share the story ending as retold in the manner that reflects their understandings and traditions. This may make the tasks more meaningful and support the learning in both subject areas

Authentic Assessment strategies: After working in pairs, students are to write a paragraph explaining reasons for the differences and similarities in the events plotted. Conclude the activity by holding a class discussion about which event was rated the most interesting and whether or not this corresponds with the author's intention (as evidenced by the complication/climax in the story).

Variations for students from diverse backgrounds. Even though students may have experienced many years of schooling, a wide range of obstacles may have impacted on their learning and this activity lends itself easily to engaging with stories told at home with family that reflect social and cultural differences. Students can use these stories just as easily to explore what else could have happened in the end and to share with partner or small groups so that the interactions supports an understanding of student diversity in the class

Part 3: Surveying Classmates and Interpreting Results

- Students then administer the survey to their sample population (this works particularly well if the learners can survey members from another class who have also read the text extract). Once they have tallied their results, students are to represent the information in a bar graph or pie chart, commenting on whether the outcomes were what they expected.*

Question prompts and example lines of inquiry
To assist students in thinking about alternative endings to the story, ask questions such as:

What would happen if the main character changed their mind about a key plot or topic?
Have you thought about the story from another (more minor) character's perspective?
What might happen if a new character was introduced now?

The teacher could consider a *steam punk* addition to the story by suggesting to students that they insert a Sci-Fi object into the plot. Discuss with students how doing this impacts the story. Are the students now more or less interested in reading the whole story? Why is that the case?

English: Year Six—Plotting a Complication: Using Graphs to Identify Narrative Structures

Resources Text/s currently being studied in class (a variety would suit this activity: perhaps a main text, for example, a novel or sophisticated picture book, matched with texts from other genres including a television or film adaptation of the book, poetry/pose, short story, media article), notebook, writing materials and graph paper or graphing software such as Excel.

Implementation Strategies
Note: this activity should be conducted after students have learnt about complications/climax in a narrative as they will need this background information to successfully complete the task.

- Students to summarise their selected text by outlining (using dot points) up to ten main and significant events in the narrative. Students to list the events in the order they occurred.

Differentiation

For an extension activity, reverse the activity by providing students with statistical data and a context (for example, data regarding employment from the Australian Bureau of Statistics (ABS) website) and require them to write an original newspaper article, using the data.

Australian Curriculum Mathematics Outcomes and Elaborations:

*ACMSP169: Identify and investigate issues involving numerical data collected from primary and secondary sources

**ACMSP169: Obtain secondary data from newspapers, the Internet and the Australian Bureau of Statistics

Numeracy Links:

*Interpreting statistical information: Interpret data displays

**Interpreting statistical information: Interpret data displays

*** Interpreting statistical information: Interpret chance events

Australian Curriculum Subject outcomes and descriptors

Outcomes:
Understand that the coherence of more complex texts relies on devices that signal text structure and guide readers, for example overviews, initial and concluding paragraphs and topic sentences, indexes or site maps or breadcrumb trails for online texts (ACELA1763)

Elaborations:
analysing the structure of media texts such as television news items and broadcasts and various types of newspaper and magazine articles writing structured paragraphs for use in a range of academic settings such as paragraph responses, reports and presentations.

The Learning task

Year Seven: Making the News: Newspaper Numeracy

In this activity, students take statistical data (or other numeracy based information) from a newspaper article and answer a series of questions to determine their numeracy knowledge when integrated with a traditionally written word text. Learning is then extended through an activity that integrates numeracy and literacy through a probability activity.

Including ATSI perspectives: The selection of topic for interrogation is critical here. Depending on the specific groups of ATSI students, the selection of article may be made on the criteria of personal interest, items that discuss cultural issues or developments or articles that engage with ATSI rights, responsibilities and the land. These are important issues for all the class. Each student has a right to be respected and their viewpoint accepted

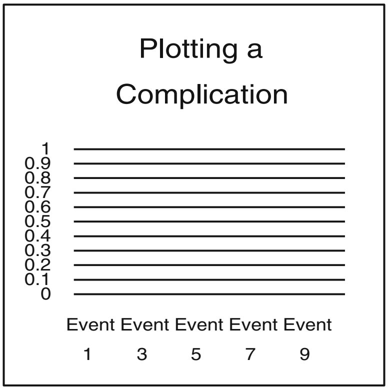
Strategies to include learners with backgrounds of oracy. This lesson is very heavily print based and some of the students may find the tasks challenging, depending on their levels of competencies in reading and with mathematical symbolic representations. It may be useful to read and repeat a short article to these students and others who may need it, to ensure it is of interest to them and to allow negotiation, interaction, drawing and discussion in unpacking the statistical information in the article into realistic, useful information before asking students to engage with the variations. Some type of base ten concrete materials may support the mathematical strategizing and students may use traditional or non- western methods of counting and calculating

Authentic Assessment strategies:

Assess student understanding of the task by reviewing student work in class or collecting for later marking. Make explicit to students the links between numeracy and literacy, encouraging them to understand that they do not need to be dichotomous topics.

Variations for students from diverse backgrounds: Many students may be challenged by the integrated nature of English and critical numeracy because their backgrounds and earlier schooling experiences may have been characterised by the timetabled separation of disciplines. It is really important that all students begin to realise realize that this type of activity is as important for their numeracy development as it is to their language development and critical literacy. If the articles are selected appropriately, it is useful to interrogate the information in order to determine whose perspective is omitted, what the information is telling in real terms and perhaps investigate why it may be written in this way.

- Students to plot their responses on a *Plotting a Complication* graph like the line graph below. Graphs can be created either manually on graph paper, or by using software such as Excel.



- Using each event, which is listed on the *x-axis*, students then plot a rating out of ten for each event on the *y-axis*: zero for least exciting/interesting and ten for most exciting/interesting.*
- Students to join the dots between each event to create a line graph.*
- Students then to start working in pairs by comparing and contrasting each other's responses and noting where the least exciting/interesting and most exciting/interesting events occurred for the students in the narrative. This will work for both the same and different texts are being used by the students.**

Question prompts and example lines of inquiry

- For students who are having difficulty selecting the ten most significant events in the plot, ask them: 'What are the events in the narrative that a reader would need to know to understand what happened in the story?'

Additional Resources-Sources
The activities contained here were sourced from:

NSW Department of Education. (2008). *Numeracy across the curriculum: An ICT approach*. Retrieved from: http://www.nlnw.nsw.edu.au/pdfs/projec08/wileypppt.pdf.

English: Year Seven—Making the News: Newspaper Numeracy

Resources Newspaper article, series of questions written on the white/black board or as an activity sheet for students to complete and writing materials.

Implementation Strategies

- Provide students with a newspaper article (either from an online or traditional newspaper) that has a focus on numeracy (not necessarily a numeracy focused topic but an article with, for example, statistics, percentages, graphs or other number focus). Samples are provided in the *Additional Resources* section below; or select a newspaper article with a topic related to the English unit of work/depth study currently being studied in class.
- Ask students to do an initial/first read-through of the newspaper article, noting in their notebooks or highlighting on the article itself what they notice about numbers, including (whichever are relevant to the selected newspaper): dates, times, statistics, percentages, graphs and numbers.**
- Develop approximately five numeracy-based questions in addition to the questions/activities that would be provided for this task for a regular English class. For example, questions such as: 'What does the graph tell about…?'; 'If 20% of the people in the article have this view, what is the total number of people interviewed?'; 'How long ago did this occur?'; 'Can you represent 35% as a percentage?'*

Question prompts and example lines of inquiry

To extend student learning and to foster positive attitudes towards the integration of numeracy and literacy in English classes, the following *probability activity* can be conducted:

- Students to re-read either the first paragraph, or another selected extract from the newspaper article and answer the following questions, displayed on the white/black board, or as an activity sheet for students to complete:
  - How many words are there altogether?
  - How many capital letters are there in the extract?
  - What is a verb?
  - How many verbs are there in the extract?
  - What is an adjective?
  - How many adjectives in the extract?
- Using the information students found in the questions above calculate the probabilities of the following:***
  - Work out the probability of finding a verb in the extract.
  - Work out the probability of finding an adjective in the extract.
  - Work out the probability of finding a word that starts with a capital letter.

Additional Resources

For a refresher on working out percentages, access: http://www.mybigtomorrow.com.au/careers/details/band-manager.

Sample newspaper articles available at:

http://www.theaustralian.com.au/national-affairs/education/writings-on-the-wall-kids-failing-basic-literacy/story-fn59nlz9-1227138940282?sv=22430a77b376cd9b946ed1acbf8fa1c3.

http://www.smh.com.au/business/the-economy/abs-population-statistics-victoria-becomes-australias-fastest-growing-state-20150924-gjudy9.html.

http://blog.id.com.au/2015/population/australian-demographic-trends/how-many-refugees-does-australia-take/ (this is a blog rather than a traditional newspaper article.)

Sources

The activities contained here were sourced from:

NSW Department of Education. (2008). *Numeracy across the curriculum: An ICT approach*. Retrieved from: http://www.nlnw.nsw.edu.au/pdfs/projec08/wileypppt.pdf.

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Question Prompts were taken directly from: *Core Skills Homework: Numeracy* available on the TES website.

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Geography and Numeracy

Debra Donnelly and Margaret Martin

At first glance, Geography may seem a simple study concentrating on locating places and determining how near or far they are from each other. Indeed, the origin of the term supports this idea. The term 'Geography' combines two Greek words, 'geo' meaning Earth and graphia 'meaning to draw or describe the earth'. (Gilbert & Hoepper, 2014) However, the contemporary discipline of Geography has a much more ambitious agenda. Modern geography is an all-encompassing discipline that seeks to understand the world and all of its human and natural complexities. It is now defined as the investigation and understanding of the earth and its features and distribution of life on earth. It is the study of the earth and its features, inhabitants and phenomena. Geography answers questions about why places have their particular environmental factors and/or human characteristics, looks to explain how and why these have changed and developed over time. These issues are investigated at all levels from local to global with an eye to management and sustainability (Taylor, Fahey, Kriewaldt, & Boon, 2012).

Geography as a discipline can be split broadly into two main subfields: human geography and physical geography. The former focuses largely on the built environment and how space is created, viewed and managed by humans as well as the influence humans have on the space they occupy. The latter examines the natural environment and how the climate, vegetation, soil, water and landforms are produced and interact. As a result of the two subfields using different approaches, a third field has emerged, which is environmental geography. Environmental geography combines physical and human geography and looks at the interactions between the environment and humans.

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All disciplines have their own nature and the central concepts that set them apart from other disciplines. Geography may have its own methodology but it also has a set of driving concepts that underpin all the topics that it encompasses.

Marsh (2008) considers the geographically literate person to have an understanding of the following concepts that underpin geographic study:

- Space (location, distance, direction, pattern, shape and arrangement)
- Place (relationships between physical and human characteristics)

This understanding is evidenced not only by the knowledge of the location of place but also the more complex comprehension and competence that explains, understands and appreciates the web of changing relationships between people, places and environments.

Young children come to geography inquiry through experiencing their direct environment, asking questions, listening to others and developing mental images of their world. Young students 'develop a sense of awe and wonder, a background of aesthetic awareness and a framework of ethical consideration'. (Rowley, 2006, p. 17). To develop a beginning sense of the relationship of one point in space to another, teachers may get their Stage 1 students to draw the playground or the local area. Battersby, Golledge and Marsh (2006) found that the foundational concepts of identity, location, magnitude and space-time were necessary for students to develop understanding of higher order concepts. For example, geospatial concepts of direction and distance are derived from location. Conceptual development occurs through a spiral curriculum approach where key concepts are revisited and extended throughout a student's schooling. The new Geography syllabus acknowledges this —each Stage builds on the expectations of students understanding increasing complexity in each concept and is designed to develop strong conceptual foundations in understanding.

Why Teach Geography

'Geography is essential to the development of all young people, and to the economic, environmental and cultural future of Australia. Geography is as important and of equal relevance in today's society as English, Mathematics, Science and History'. (AGTA, 2007)

Geography builds a sense of national identity and of Australia's place in the world. Through Geography, students come to an understanding of Australia's environment and population density and land uses from our vast coastlines to the bush and outback. Geography aids students to see the influence and implications of Australia's distance from Europe and North America and our closeness to Asia.

Geography helps us make decisions about the big issues affecting the quality of our lives and landscapes. Geography deals with the big relevant issues—climate change, water and land management, ageing populations and the globalised economy. Geography enables students to examine some of the most important issues facing the future and develops informed citizens. Issues such as sustainability of our regional, national and global environments; diverse cultural engagement with land and the resulting land use conflicts; population density and sustainability; global inequality and the use of natural resources; and the protection and utilisation of natural habitats.

Geography nurtures our natural curiosity in and appreciation of the world's people and places. Geography informs students about their world engaging them from a local neighbourhood to national to global level. 'The appreciation of environments in Australia and elsewhere contributes to students' valuing and caring for places'. P. 3

Geography creates spatially literate students. Through the intersection of Geography and Mathematics, students develop their understandings and uses of spatial information such as breadth, depth and scope. Students gain deep understanding of essential spatial concepts such as location, distribution, scale, spatial association, spatial interaction and spatial interdependence. Spatial technologies such as geographical information systems (GIS) are being increasingly used in Geography classrooms.

Geography develops competencies essential in the workplace and can lead to careers in areas such as spatial sciences, resource management and urban planning. Geography prepares students for the workplace giving them skills in collection, analysis and organisation of information, the use of mathematical ideas and techniques, problem solving and cultural awareness and understanding.

Geography is an excellent medium for education. The rigour of this academic study enhances student capacity to explain, rather than just describe. Higher order thinking skills are developed. Geography develops and integrates a wide range of skills such as literacy, numeracy, oracy, graphicacy, ICT and decision-making. It also caters for a variety of learning style.

Geography and Numeracy

The skills of Geography and Numeracy work together in a symbiotic partnership. Geography requires a multi-literacy approach with an emphasis on numeracy as well as literacy. The real-world context provided by the geographical setting gives the skills of numeracy relevance and authenticity. The skills of acquiring, processing and communicating geographical information provide explicit links to the development of numeracy skills. Acquiring and processing geographical information require geospatial and computation skills reliant on mathematical principles and practices; while communicating of findings and conclusions require students to construct and present information in statistical, graphical and diagrammatic forms. These skill areas, and the literacy skills inherent in them, link directly to the development of the key competencies of collecting, analysing and organising information and communicating ideas and information (Palmer & Birch, 2004).

Numeracy is fundamental to many of the activities in Geography. Recent research in primary mathematics education by Sullivan et al. (2014) and Russo (2016) highlight the benefits of setting mathematical challenges in real-world contexts and recommend pedagogies based on a problem-solving co-operative learning approach. This perfectly matches the observation, exploration and action orientation of local, regional and global Geographic investigations. A recent Australian study demonstrated that using geographic data, early primary aged students were able to move beyond simple observation and make sense of data by relating it to their own lives and society in general. By seeing the data as ‘numbers with a human face’ (p. 39), the students were also able to check their discoveries against prior knowledge and begin to adjust their worldview accordingly (Ballin, 2016). Geography’s solution focus and fieldwork elements provide an educational setting to channel the physical, intellectual and emotional involvements that are necessary to enable mathematical thinking and that can lessen mathematics anxiety in young children (Hudson, Henderson, & Hudson, 2015).

Content within the study of all Geography courses requires students to develop numeracy skills in an applied environment. They need to be able to analyse statistical data, construct and interpret graphs and maps, and use latitude and longitude. Geography has an extensive list of ‘tools’—many of which are based on numeracy. Geographers must be able to read maps, use scale calculate bearings, vertical exaggeration, gradients, measure distance, estimate areas, interpret and construct a wide variety graphs, tabulate and calculate the results of surveys etc. Graphs, also called charts, take many forms and include digital and non-digital mediums. Examples include, but are not limited to, tally charts, pictographs, column graphs, line graphs, pie graphs, weather charts, climate graphs and population profiles.

Statistics also take many forms and include digital and non-digital mediums. Students will begin with basic data tables and progress to complex representations of statistics on common themes. Graphs and statistics are used to collate, organise, illustrate, summarise and compare patterns, relationships and trends in geographical data and information. Spatial technologies include any software or hardware that interacts with real-world locations. Examples include, but are not limited to, virtual maps, satellite images, global positioning systems (GPS), geographic information systems (GIS), remote sensing and augmented reality. Spatial technologies are used to visualise, manipulate, analyse, display and record spatial data (Catling & Willy, 2009).

Conclusion

Geography is a vehicle through which critical numeracy skills can be taught in an engaging, real-life context and linked to real-world problem solving and action. Geography involves hard, critical thinking and the development of important knowledge and skills and facilitates real-world application of numeracy skills. The study of Geography from kindergarten to Year 12 develops future citizens with literacy and numeracy knowledge, skills and values to make informed decisions about world issues. Geography highlights positive values such as sustainability, social justice and human rights, and assists students to take responsibility for their actions and to see themselves as global citizens who can contribute to a more peaceful and just world.

To quote Tim Costello, the CEO of World Vision Australia and patron of the Australian Geography Teachers Association, ‘Our children need a great education that equips them to be global citizens in an increasingly globalised world—and our world needs engaged and well-educated Australians with a global ethic’. Numeracy is vital in the development of this global citizen who is able to investigate, understand and take action.

Differentiation students can experiment with other root vegetables and see if they also grow in water (they should as all their nourishment is stored in the tuber or bulb). They can measure informally using paddle pops sticks and making a mark or taping thin pieces of fine cardboard to the back of the glass and making carefully. Unifix and other materials that connect can be used to measure (paper clips, clothes pegs etc.). Later, other vegetables may be grown in the school garden.	**Australian Curriculum Mathematics Outcomes** (ACMMG006)	Numeracy Links *Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language *comparing objects directly, by placing one object against another to determine which is longer
Australian Curriculum Subject outcomes and elaborations ACSSU002 Needs of living things ACSHE013 Observation ACSIS014 Questioning the familiar ACSIS012 Sharing observations	**The Learning Task: Foundation—Pot Plants and Potatoes** In this task the students are able to see what is going on at both ends of the sweet potato as it grows in the water. They are able to appreciate what happens in the growth of what they may eat for dinner.	**Including ATSI perspectives** This activity is perfect for students in this group. These students may have a strong connection to the land and may have opportunities to grow something in their gardens at home although traditional hunters and gatherers, not farmers. The class may wish to plant other things in the school garden and may choose traditional bush tucker roots as these are Australian http://www.survival.org.au/bush_tucker_diet.h
Strategies to include learners with a background of oracy: Many of these students may have the background knowledge for this task and the class may wish to try this task with other root vegetables that are commonly eaten in their diet. Although traditionally many peoples from backgrounds of oracy were nomadic, in recent times this changed and they may have had a garden in their original homeland or may have one in their new homeland. The students will be able to follow the demonstration by the teacher and their peers but may need the language associated with reflecting and explaining supported by visual materials	**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and encouraging short bursts of focussed discussion. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of group or individual plants.	**Variations for students from diverse social contexts**: Some students may be really familiar with sweet potato, having eaten them at home as chips, baked or boiled and mashed. Many may never have seen how they grow so it may be useful to roast small cubes of sweet potato on a baking tray, sprayed lightly with oil and allow the students to taste the plant that they are growing in the glasses. Some students may want to plant these in a home garden so it is useful to be aware that only one 'eye' is required per plant and large sweet potatoes can be cut in pieces so that each one has an 'eye'

Foundation: Science—Pot Plants and Potatoes

Resources Each group (or individual) will need one small sweet potato, four toothpicks, a drinking glass and water. The sweet potato needs to be small enough to fit into the drinking glass with one-half sticking out the top and the other just above the bottom of the glass.

Background for teachers
Science in the early years is predominantly a matter of directing children's attention to parts of their environment that they may not otherwise notice and redirecting them before their interest wanes. Unexpected connections between parts of that environment can generate and sustain considerable situational interest.

Science Concepts Plants are composed of roots, stems, leaves and some reproductive part, such as a flower or a cone. Some plants reproduce through these and others can reproduce from cuttings or tubers. Sweet potato (called '*kumera*' in some parts of the world) is a very useful plant with a starchy tuber that is very tasty when it is cooked. Sweet potato can reproduce from this tuber or from flowers that grow from their stems. Many children will only have seen sweet potato in bins in the fruit market and they have the idea that this vegetable can grow into something that is recognisable as a plant which can evoke considerable enthusiasm. This activity allows children to watch the vegetative reproduction of a sweet potato. If the water is topped up, the potato will grow roots from its bottom half and stems and leaves from its top. If left long enough, some potatoes may flower.

Implementation
Activity Origin: Adapted from Hinkler 2015, Activity 65.
Each group/individual should:

- Fill the drinking glass with water.
- Stick toothpicks around the middle of the sweet potato, so that they are evenly spaced.
- Place the potato into the glass.
- Make sure that the bottom of the potato is in the water.
- Place the 'potato-in-water' equipment on a shelf where they are in the sun for part of the day.
- Check their potato every day.

Reflection Activity
Each day, each group should discuss what has happened to their sweet potato.

- Are different things happening to different ends of the sweet potato?
- How much time passed before something happened?
- How could the group keep a clear record of what happened when?
- What does this activity show about plants?
- How could we measure the plants?

Differentiation

This activity can be carried out in a variety of contexts that incorporate natural and made-made features. It can be at a beach, in a field, around a river (all water environments need a great deal of extra supervision) or even in the school garden. To make it more complex for some students they may be able to determine if the man-made objects are made from natural materials that are obviously identifiable. These may be wood, stone (as in gavel pathways) soil or sand.

Numeracy links

Australian Curriculum Outcomes and elaborations—Year 1

Using units of measurement—ACMMG019
Measure and compare the lengths and capacities of pairs of objects using uniform informal units.
Shape—ACMMG022
Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features
Location and transformation—ACMMG023, ACMMG044
Give and follow directions to familiar locations
Interpret simple maps of familiar locations and identify the relative positions of key features

Australian Curriculum Outcomes and elaborations—Geography

Outcomes: Describes features of places and the connections people have with places GE1-1
Identifies ways in which people interact with and care for places GE1-2
Communicates geographical information and uses geographical tools for inquiry
Content: Investigate places and how they can be cared for, for example description of the natural and human features of places.

The Learning Task—YEAR 1

- Students use uniform, informal units to measure lengths and distances by placing the units end-to-end without gaps or overlaps.
- Give and follow directions to familiar locations.
- Interpret simple maps by identifying objects in different locations.
- Make simple models from memory, photographs, drawings or descriptions.
- Draw a sketch of a simple model.
- Use drawings to represent the positions of objects along a path.

Including ATSI Perspectives

The implementation of this lesson in an outdoor setting supports the learning preferences of many ATSI students and other who like to be out of the classroom environment. These students can frequently discuss the natural world in ways that suit their backgrounds and heritage. It may be wise to investigate if the land on which you taking this lesson has historical importance for these students and their people and include the local community in the discussion.

Strategies to include learners with oral backgrounds

Many of these students may engage more effectively with the learning tasks if they are developed in terms of a narrative, however, this type of activity is ideal as it involves mainly oral language and representations. The key words 'near' and 'far' as quantitative descriptors are context relevant and may need to be discussed with all the students.

Authentic Assessment strategies

Students are to create a video interview. Students write their own questions regarding Kandinsky's circles and interview a fellow student. The video is a record of the students' understanding of the mathematical concepts in the image. The interview will also determine their ability to use mathematical language in context. The video planned for assessment purposed may not be culturally acceptable for all ATSI students or for some Islamic students.

Variations for students from diverse social contexts

The identification of the man- made and natural may not present difficulties but it may be useful to indicate that trees that are planted in certain ways as still part of the natural category as are plants in pots, lawns and other artificially organised natural elements of the environments. This discussion may be useful for all students.

Geography: Year One—Natural and Man-Made Places

Resources

1. http://www.palms.edu.au/course/view.php?id=30
2. www.calisphere.universityofcalifornia.edu/themed…/k-6guidelines.pdf
3. https://www.google.com.au/#q=google+earth
4. http://www.curriculumsupport.education.nsw.gov.au/countmein/children_plasticine_snakes.html
5. https://www.superteacherworksheets.com/maps/printables/neighborhood-map.pdf
6. https://www.pinterest.com/pin/151996556145035274/

Local park or playground if large and diverse enough, prepared simple maps of selected area, markers to distinguish natural from man-made features, digital camera, informal measures, large pictures of natural and man-made features.

Introduction

Discuss natural and man-made with students using the Google Earth or first web link.

Students will begin to classify places as natural or man-made.

Introduce an Aboriginal perspective to the concept of place and natural/human places.

Pedagogical strategies
Students look at photographs of places and decide whether they are natural or human. Use Google Earth to find local area and create an overview of what is there.

Introduce the concept of measurement using uniform informal measurements using the plasticine snake (link above).

Students to work in groups to access real-world examples of places and classify them as natural or human. They construct or interpret maps and investigate objects in the field or where this is impractical, investigate through the use of Google Earth. Students visit the school grounds or a local park.

Differentiation

Students can use globes and atlases to understand the world is not flat but that it fits together spherically and then use the handouts. On the smartboard, the continents can be dragged and overlapped so that gives an idea of relative size. Look at Australia in comparison to the other continents one at a time and place all continents in order largest–smallest, smallest to largest.

Numeracy links

Australian Curriculum Outcomes and elaborations—Year 2

Using units of measurement—ACMMG044
Interpret simple maps of familiar locations and identify the relative positions of key

Data representation and interpretation—ACMSP049, ACMSP050
Collect check and classify data
Create displays of data suing lists, tables and picture graphs and interpret them.

Australian Curriculum Outcomes and elaborations—Geography

People and places
Describes features of places and the connections people have with them GE-1
Communicates geographic information and uses geographic tools for inquiry GE-3
Students investigate places across a range of scales within Australia
Investigate people's connections and access to places—discussion of why people visit places, identification of factors that limit access to places.

THE LEARNING TASK—YEAR 2

- Students arrange objects in rows or columns according to characteristics to form a display.
- Introduce the tally.
- Compare and order several shapes and objects based on area using appropriate uniform informal units.

Including ATSI perspectives: These students have significant connections to place and so should engage well with the content. They can also, like other students who have not visited or have connections outside Australia, focus on Australia itself and name places that are interstate, compare the size of the states and may links to the original places of the kinfolk if they know this. In some settings the connections to place may focus explicitly on local scale within Australia. It may also be possible to link various clans or 'mobs' geographically. It would be good top involve community spokespeople or parents in this activity.

Strategies to include learners with oral backgrounds

Most, if not all of these students will have come from other countries and settled in Australia. They will have links to other countries and it may be wise to locate exactly where they are from on the continents so that you can offer the assistance they will need to complete these activities. The key words may also be prepared in advance so they are available for the students to copy or draw over for their assisted sentences.

Authentic Assessment strategies

Students perform real-world tasks that demonstrate meaningful application of essential knowledge and skills.

This will be demonstrated by their ability to use methods of informal but uniform measurement, to understand the concept of distance by demonstrating an ability to place objects in their relative location on a map.

Variations for students from diverse social contexts

It may be wise to ask students from the class to be prepared for this activity as it may be challenging for some students who have not travelled or who do not have extended families, links outside the immediate environment, or do not have holidays away from home. Many students may like to nominate a place they might like to visit.

- Use simplified maps to note whether features (preselected by teacher) they pass are natural or human. Locate and record these on maps
- Use terms near and far to describe their location relative to the starting point
- Destination investigation—conduct a 360° observation identifying and classifying objects as natural or human
- Record these and describe some of these objects as near or far
- Students measure distances using informal units and use results to validate near or far
- Students of differing heights stand next to several taller objects (trees, buildings). Take a digital photo (used later for consolidation of the task). Students select one of these students as their informal measurement unit and try to estimate how many students would make up the height of this object
- Select an area of trees or other objects and have students 'hug' them in order to measure width
- Have students consider where they would be likely/unlikely to find wildlife (birds, possums) or people.

Task: In class, students use their new information to construct a model of the park or school using blocks and plasticine ensuring they show natural and human features and where wildlife or people would most likely be found and write descriptions using the terms 'near' and 'far'.

Geography: Year Two—Making Connections on a Local Scale

Resources

1. https://www.meta-chart.com/bar, http://www.mathwire.com/templates/bargraph.pdf
2. https://www.your-vector-maps.com/world/-mollweide-projection-oval-format-/-continents-of-world-colored-map-/?image=wrld-mo-4
3. http://www.millersville.edu/~cgeiger/GEOG281/MapsText2013/MapsSection1/Maps1UnitD/images/2b_04_01_proj_PLA-S-polar.png

Handout maps of projections that minimise distortion—Mollweide is an easily recognisable globe projection but needs to have Antarctica obtained from a Polar projection of the same scale. A world map with the continents labelled is displayed.

Students discover their connections at a local scale. Pedagogical strategies

Discuss where students have visited recently and places they go regularly.

Differentiation

Students can use globes and atlases to understand the world is not flat but that it fits together spherically and then use the handouts. On the smartboard, the continents can be dragged and overlapped so that gives an idea of relative size. Look at Australia in comparison to the other continents one at a time and place all continents in order largest – smallest, smallest to largest.

Numeracy links

Australian Curriculum Outcomes and elaborations—Year 3

Using units of measurement—ACMMG061

Measure, order and compare objects using familiar metric units of length, mass and capacity

Data representation and interpretation—ACMSP068, ACMSP069, ACMSP070

Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording

Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs with and without the use of digital technologies

Interpret and compare data displays

Australian Curriculum Outcomes and Elaborations: Geography

Describes features of places and the connections people have with them GE-1

Communicates geographic information and uses geographic tools for inquiry GE-3

Students investigate places across a range of scales within Australia

Investigate people’s connections and access to places—discussion of why people visit places, identification of factors that limit access to places

THE LEARNING TASK—YEAR 3

- Students Identify temperature as a measure of how hot or cold.
- Use everyday language to describe temperature eg. “cold” “warm” “hot”
- Recognise the need for formal units to measure temperature
- Use a thermometer to measure and compare temperatures to the nearest degree Celsius
- Record temperature to the nearest degree using the symbol for degrees.
- Use a thermometer to take and record daily temperatures
- Recognise that data can be collected by the user or others

Including ATSI perspectives: Students then use the Bureau of Meteorology website and investigate the data collected by others. Discussion should be generated on the reliability of this information. Discuss with students the elements of climate and seasons –This link introduces all the students to the indigenous concept for weather and climate. Visit Maung, Jawoyn, D’harawal, Brambuk, Nyoongar, Walabunna location. Record the number of seasons recognised by indigenous people each of these places. How does this differ from the broader populations ideas and how do they differ from each other? Visit the links to the graphs of temperature and rainfall for these places and discuss in your group whether the indigenous description of the season is a good way of describing what the graphs show. Report and justify your conclusions to the class

Strategies to include learners with oral backgrounds

Most, if not all of these students will have come from other countries and settled in Australia. They will have links to other countries and it may be wise to locate exactly where they are from on the continents so that you can offer the assistance they will need to complete these activities. The key words may also be prepared in advance so they are available for the students to copy or draw over for their assisted sentences.

Authentic Assessment strategies

Authentic Assessment Strategies

Students perform real-world tasks that demonstrate meaningful application of essential knowledge and skills.

This will be demonstrated by their ability to use methods of informal but uniform measurement, to understand the concept of distance by demonstrating an ability to place objects in their relative location on a map.

Variations for students from diverse social contexts

There may be a number of students who are unfamiliar with the diversity of climates and physical environments in Australia. They may be students from other countries who have little general knowledge about the country or students who really only know their own part of Australia and so explicit links need to be made linking both the two language codes and the distance and positioning of students’ own environments and those being studied.

Students

- Make a list of six (6) places in the past week
- Note how many times each of these places was visited in the week
- Graph this information using a bar chart format
- How far away from home are these places? Why did you visit these places—what are your connections to them? Discuss with a partner
- Begin to explore a wider world using a global scale—they investigate the continents and oceans of the world in small groups.

Task: With maps provided, students:

- Label the continents
- Cut out the continents from the Mollweide and polar projections and collaboratively overlay the continents in order to gauge their area
- Place the cut out continents on the grid and use these to estimate areas more accurately
- Rank the continents from largest to smallest, make special note of Australia being the smallest continent
- Students identify places (other than Australia) they have connections to—this can be overseas countries they have visited or where their family may have emigrated from (recently or historically) or they may have heard about in the news recently. With teacher's help, (i) identify what continent these places are on (ii) draw lines to the continents with which the class has connections (iii) create a class tally of the connections to the different continents (iv) shade the continents in different colours according to their rank in the tally
- Draw lines to show their connections to continents and write about these places and the connection
- Consider the distance these places are from them and identify this as a factor influencing their accessibility to them.

Teacher references

http://resources.arcgis.com/EN/HELP/MAIN/10.1/index.html#//003r0000003m000000

Geography: Year Three—Climate

Resources

1. http://www.bom.gov.au/ http://www.mathsisfun.com/data/data-graph.php#instr
2. http://www.rmets.org/weather-and- climate/observing/make-rain-gauge

3. http://www.bom.gov.au/iwk/?ref=ftr
4. http://www.bom.gov.au/jsp/ncc/cdio/cvg/av?p_stn_num=014015&p_prim_element_index=0&p_display_type=statGraph&period_of_avg=ALL&normals_years=allYearOfData&staticPage= Darwin figures temperature
5. http://www.bom.gov.au/jsp/ncc/cdio/cvg/av?p_stn_num=014015&p_prim_element_index=18&p_display_type=statGraph&period_of_avg=ALL&normals_years=allYearOfData&staticPage= Darwin rainfall
6. http://www.metoffice.gov.uk/media/pdf/8/6/weather_diary.pdf

Maps of Australia, insulated containers of hot, warm, cool and cold water, thermometers—this activity should be conducted in groups so multiples of these resources are needed, Containers of water, constructed rain gauges, stop watches, measuring cylinder, watering can, stop watch, graphing paper and pencils formatted tables for recording observations.

Introduction

One variable of changing environments has been selected for investigation—climate. This feature of place was selected as it forms the basis for natural systems and significantly affects people. The activity investigates two fundamental causes of climate variation—temperature and rainfall. It looks at how these variables are recorded and how the terminology of climate in the broader population differs from indigenous terminology.

Pedagogical strategies

Using maps of Australia that show the Capital Cities, students:

- Visit web link 1 and record the temperatures of the Capital cities, discuss the reasons for the differences in temperature in these cities today
- Visit website 2 to learn about line graphs or use excel to create a line graph using these temperature figures
- Each group receives an amount of water in the container with a thermometer and a container. The temperature is measured and recorded
- Discuss mathematical metalanguage for their recorded temperature. Take turns as time keeper, measurer and recorder
- Repeat with different quantity and warmth of water
- Plot results on a graph
- Using the watering can and the constructed rain gauge, pour a shower of water into the gauge for 5 s, stop empty gauge into measuring cylinder and record the result, shower water into the gauge for 10, 15, 20, 25 s and repeat measurement and recording each time
- Students visit website 2 to plot this information onto a column graph or use Excel to generate a column graph
- Set up a thermometer and the rain gauge and record ‘weather’ for a week using the weather diary—web link 6
- Discuss findings with the class daily.

Differentiation

This task caters to a variety of learning styles and structures.
Students listen to explicit instruction and complete a visual task relating to maps
Students work in small group and support each other in their understanding and application of compass direction
ICT games are visually engaging and at student's pace

Numeracy links

Australian Curriculum Outcomes and elaborations—Year 4

Using units of measurement—ACMMG084
Use scaled instruments to measure and compare lengths, masses and capacities and temperatures

Location and transformation—ACMMG090
Use simple scales, legends and directions to interpret information contained in basic maps

Australian Curriculum Outcomes and Elaborations

The Earth's Environment
Examines features and characteristics of places and environments GE-1
Acquires and communicates geographical information using geographical tools for inquiry
The Australian continent
Location of Australia's states, territories and major cities
Identification of Countries/Places of Aboriginal and Torres Strait Islander Peoples.

THE LEARNING TASK—YEAR 4

- Uses simple scales, legends and directions to interpret information contained in basic maps.
- Use a compass to find north and then east, south and west on a compass rose.
- Use an arrow to represent north on a map.
- Determine the directions north, east, south and west when given one of the directions.
- Use north, east, south and west to describe the location of a particular object in relation to another object.
- Measure distances using formal units.

Including ATSI perspectives: This activity should support ATSI students in a number of ways as it utilises ASTI pedagogies for all the class—it caters for the instructional sequence of see and them do and allows students to share with a partner. It also explores country which is an important pat of learning for this group of students. The students may also know the Aboriginal names and their meanings for some of the places on the map and should be allowed to identify the places by their traditional names. Although they can complete the activity on mapping, these students may also have other ways of describing location which are legitimate.

Strategies to include learners with oral backgrounds

Many of these students may not be familiar with the geography of Australia and may even be new arrivals. The area of Australia may not be easily understood and it may be a good idea to preface this lesson by reading and sharing the explicit pictures, diagrams and illustrations in the text 'Are We There Yet?' by Alison Lester. It may be interesting for this group to see that traditional life in Australian can still be found to some degree in some locations.

Authentic Assessment strategies

Authentic assessments, offer direct evidence of application and construction of knowledge. This is evidenced in this task as students demonstrate proficiency in the use of compass directions and use compass direction to articulate their understanding of the relative position of States, Territories and Capital Cities.

Variations for students from diverse social contexts:

Many students may not know Australia very well as a country and the same concern that were considered for students with backgrounds of oracy could also be appropriate for these students.

Geography: Year Four—Identifying Australia in the Continents

Resources
Atlas
Map of Australia with a simple grid overlay—this should be created with the grid small enough for students to count an appropriate number of squares
http://www.mathsisfun.com/games/direction-nsew-.html

Introduction

This activity is fundamental to the geographic use of maps. It introduces students to formal maps and the concept of direction and the position of features in relation to each other. Students can begin to articulate relationships of features by giving direction.

Pedagogical strategies
Students identify Australia on a world map of continents. Students use the outline map of Australia in conjunction with an atlas (or whiteboard) to:

- Label the states and territories
- Identify the state in which they live
- Know their state capital city, Australia's capital city
- If using an atlas can they find where they live? Label the map
- Locate the capitals in each of the states and territories
- This part of the activity is a think-pair-share task. Visit the Math is fun link above to learn the four cardinal points of the compass and how to move in these directions. Hand out a map of Australia with a grid overlay (similar scale to the game) that has the states, territories and capitals marked.

1. Draw a compass on this map (or provide a map with a 4-point compass already included)
2. Using the same movement pattern as the game—i.e you can't move diagonally across a square—students follow the instructions to move between capital cities and then create with a partner ask how to get from A to B to move between capital cities

Differentiation

The students can investigate any county to compare with Australia on the table. They can select somewhere from a news item, a place they would like to visit or a place that is the country connected with an interest or hobby, for example, Madrid or Barcelona for soccer fans could mean Italy or Spain could be investigated and compaed to Austraila

Numeracy links

Australian Curriculum Outcomes and elaborations—Year 5

Location and transformation—ACMMG113, ACMMG143
Use a grid reference system to describe locations. Describe routes using landmarks and directional language.
Introduce the Cartesian coordinate system, using four quadrants
Data Representation and interpretation—ACMSP119
Construct displays, including column graphs, dot plots and tables, appropriate for data type, with or without the use of digital technologies.

Australian Curriculum Subject outcome codes and elaborations

Factors that shape places
Describes the diverse characteristics of places
explains the interaction and connections between people, places and environment
acquires, processes and communicates geographical information using geographical tools for inquiry

THE LEARNING TASK—YEAR 5

- Patterns and algebra: Introduce the coordinate system using all 4 quadrants
- Recognise that the number plan (Cartesian plane) is a visual way pf describing location on a grid
- Recognise that the number plane consists of a horizontal axis and a vertical axis creating 4 quadrants
- Recognise the horizontal and vertical axis meet at right angles
- Plot and label points given coordinates, in all four quadrants of the number plane
- Recognise the order of coordinates is important when locating points on the number plane

Including ATSI perspectives
All students may wish to select and investigate parts of Australia for comparison. They may like to compare the Red centre with the more coastal areas and complete an entirely Australian table as the diversity of Australia allows for this. ATSI students may also wish to explore the islands off Australia or other areas connected to their heritage. They may wish to include some other spatial measures and language that are culturally relevant for them. A community member may be available to help with this activity

Strategies to include learners with oral backgrounds

These students may like to compare their new country with their old country and find similarities and differences in the rainfall, temperature etc. They may wish to add information about their homeland that relates to the climate etc. and to draw these rather than write. They may have culturally specific ways of expressing space and distance and alterative measures to contribute to the discussion. As always, learning is supported by the use of narrative and storytelling to support the cognitive processes of these and other students.

Authentic Assessment strategies

Authentic assessment occurs when students can demonstrate their ability to use latitude and longitude to locate places on maps and explain their calculation and relationship with the Cartesian plane.

Students construct their knowledge when comparing North America (or other selected places) and Australia and accounting for the differences in temperature, rainfall and other characteristics.

Variations for students from diverse social contexts

These students may wish to select a country that they have connections to, have family or just would like to visit because they have an interest in it. They may wish to find places that are on the news and may need to be supported in finding the counties of the places they have heard of as cities.

3. Use a ruler to measure the distances between capital cities and record the cities that are farthest apart and closest together
4. Use these measurements and the map scale to determine real-life distances between cities.

Teacher references
https://www.your-vector-maps.com/world/-mollweide-projection-oval-format-/-continents-of-world-colored-map-/?image=wrld-mo-4 http://www.clipartbest.com/clipart-RiAAaoBoT (map) https://dearingdraws.com/downloads/square-grid-template-29-20/ (grid) http://www.australiancurriculumlessons.com.au/2013/08/17/introducing-mapping-skills-lesson-year-234/

Geography: Year Five—Longitude and Latitude

Resources

1. http://www.layers-of-learning.com/a-grid-on-our-earth-an-exploration-on-map-grids/
2. http://www.worldmapsonline.com/LESSON-PLANS/4-5-world-grid-system-world-map-activity-1-print.pdf
3. http://www.worldmapsonline.com/LESSON-PLANS/6-global-grid-system-world-map-lesson-4.htm http://www.worldatlas.com/webimage/countrys/namerica/namera.htm
4. http://www.enchantedlearning.com/biomes/
5. https://online.science.psu.edu/biol011_active002/node/4347

Blank map of world with a simplified latitude and longitude grid with the intersection of the main axes obvious on the map, variety of thick nibbed coloured pencils or pens, maps with only latitude and longitude are shown.

Introduction

Linking to learning in mathematics—the Cartesian coordinate system—which forms the latitude and longitude system. Use quadrants of the world map named northeast, northwest, southeast and southwest.

Pedagogical strategies
Students use the handout map (from website 3) and website 1 to

- Identify and colour code the Equator and the Prime meridian. Record value of these lines

Differentiation

These task may be quite complex for some students so the independent tasks could be completed in pairs or with teacher support. The graphing of data in various ways may only involve one way for some students who are not familiar with the Excel program. The teacher may need to provide the information from the government sites in simple form for some students whilst more capable students can access the information for themselves.

Numeracy links

Australian Curriculum Outcomes and elaborations—Year 6

Fractions and decimals—ACMNA127

Find the simple fraction of a quantity where the result is a whole number, with or without digital technologies.

Data Representation and interpretation—ACMSP119, ACMSP147

Construct displays, including column graphs, dot plots and tables, appropriate for data type, with or without the use of digital technologies

Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables.

Australian Curriculum Subject outcome codes and elaborations

A diverse and connected world

Explains interactions and connections between people, places and environments GE3-2

Acquires, processes and communicates geographical information using geographical tools for inquiry GE3-4 Investigate connections between Australia and other countries of the world for example Description of connections Australia has with other countries eg trade, **migration**, tourism, aid and other activities

THE LEARNING TASK—YEAR 6

- Draw and interpret timelines using a given scale
- Determine a suitable scale and draw an accurate timeline using the scale e.g., represent events using a many to one scale of 1cm = 10 years
- Interpret a given timeline using a given scale
- Tabulates collected data, including numerical data
- Consider the data type to determine and draw the most appropriate displays such as column graphs, dot plots and line graphs
- Interpret and compare different displays of the same data set to determine the most appropriate display for the data.

Including ATSI perspectives: This topic may be difficult for some students to discuss, depending on their current relationships and locations. Depending on their background, these students may have different worldviews about other people coming to Australia and the subsequent treatment of their mobs, culture and languages by them. People who migrated to Australia also brought arrange of disease, flora and fauna that impacted negatively on the native occupants. They also did not have respect for the land that was critical to indigenous cultures and beliefs. It is important that all discussions are treated with respect and that a community of learners each have rights to own views and opinions

Strategies to include learners with oral backgrounds: Many if these students will be relatively recent arrivals in Australia and may have extremely revealing personal stories to add to the data and statistics, giving them richness and personal meaning. These students also are un likely to be as skilful with technology as many of the other students and may need to record their finding visually in another format or draw parts of their own journey to show their understanding of the migration process and how it changes the culture and construction of Australian society. This may cause some distress so needs to be treated sensitively.

Authentic Assessment strategies

Students transfer information from a narrative form to a diagrammatic representation.

Students will review a number of methods of graphing information for visual display and select the most appropriate format.

Students will review a number of methods of graphing information for visual display and select the most appropriate format. They will need to justify this selection.

Variations for students from diverse social contexts

The topic of immigration may be a sensitive area for a variety of students for a number of reasons. Students may make comments about others coming to Australia to take jobs, buy up property, live on the taxpayers' money and other types of comment that they have heard from adults. It may be wise to anticipate any difficult discussions amongst the class cohort and preface the tasks with discussions of equity, rights and freedom to live peacefully and safely.

- Using a compass to determine location north or south of the Equator and east or west of the Prime meridian
- In small groups undertake research to investigate latitude and longitude
- The lines of latitude have not been completely labelled—they are missing their north or south classification. Use your compass to add these
- Using the map that only has lines of latitude, find 0 value, 40 N and S and 90 N and S. Using these observations, describe what you think latitude is
- Using the map that only has lines of longitude, find 0 value, 40 E and W, 90 E and W and 180 E and W. Using these observations, describe what you think longitude is
- Understand why the terms parallel and meridian are used
- Use the map with both coordinates and locate a variety of places—recognising that the intersection of the lines of latitude and longitude allow for accurate location. Recognise that the order of coordinates is important when locating places on a map
- Investigate and report on how the natural environment influences people and places, and particularly discuss how climate influences the distribution of where people live
- Locate North America. Use an outline map to colour the three countries which make up this continent. Develop a key for this map
- Create a table and compare North America and Australia using these headings: Latitudinal extent, lowest line of latitude, highest line of latitude, eastern or western hemisphere, lowest temperature, highest temperature, lowest rainfall, highest rainfall, biomes.

Teacher References
http://www.sjusd.org/leland/teachers/sgillis/biomes/Act1_6.pdf, http://www.homeschoolcreations.com/NorthAmerica.html http://waynesword.palomar.edu/biomes.htm

Geography: Year Six—Population Growth

Resources

1. http://www.migrationheritage.nsw.gov.au/belongings-home/about-belongings/australias-migration-history/ http://www.abs.gov.au/videos/221-0915-001/ABS%20Snapshot%20March%202015.html
2. http://www.abs.gov.au/ausstats/abs%40.nsf/94713ad445ff1425ca25682000192af2/1647509ef7e25faaca2568a900154b63?OpenDocument pop clock aust
3. http://www.worldometers.info/world-population/
4. http://www.abs.gov.au/websitedbs/d3310114.nsf/Home/Animated+Historical+Population+Chart

5. https://www.youtube.com/watch?v=0PFlCPKIpRk
6. http://dohistory.org/on_your_own/toolkit/timeline.html
7. http://www.abs.gov.au/ausstats/abs@.nsf/mf/3412.0/ top ten countries by birth
8. http://waves.anmm.gov.au/Immigration-Stories/Immigration-history.aspx
9. www.youtube.com/watch?v=teq__HPNpSI—Australian immigration
10. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3105.0.65.0012006?OpenDocument
11. http://www.abs.gov.au/ausstats/abs@.nsf/featurearticlesbyCatalogue/3FAE5CC31ED79DB8CA256B2700839248?OpenDocument

Coloured pens or pencils, cardboard, access to computers, rulers, customised sheets of belonging.

Introduction

Class discussion of contributions to population growth and why Australia's population has grown.

Pedagogical strategies

- Students use the population clock (web link 3) to watch Australia's increase and read the associated information on the ABS site to note the rate of increase from natural increase and the rate from migration. Compare this to the rate of increase in world population (web link 4)

- Watch the animation in website 5 to see how Australia's population grew from 1788
- Use web link 2 to look at how our population is changing now and look at the changing numbers and distribution
- Discuss some of the implications of these changes including the changing growth rates between states and territories and the changing migration patterns for new arrivals
- Construct a timeline—watch the YouTube clip web link 5 and then use web link 6 to understand how to construct a timeline
- Read 'Belonging' and create a table to record important dates and happenings
- Teacher to access ABS and provide student-friendly information on Australia's migration patterns in selected years (web link 9). There should be some recording of migration by continent and selected countries. Census Statistics for Australia begin 1901
- Use the data sheet for the year assigned, identify the continents from which migrants came
- Enter the data on an excel spreadsheet, using the graphing function
- Groups write a report about the migration pattern in the selected year and display choice
- Use this to draw the link between Australia and the countries that people have come from
- Investigate the links found to explain the impact these migrants have had on modern day Australia.

Differentiation

For students of various locations, this lesson may be a study of their own landscapes and it may be possible to investigate data around employment created by the landscape's economic value. Also, shifts in population to support the tourist industry and the ways in which the landscape has changed and developed as the result of tourism, including the building of accommodation, the provision of food outlets and entertainment could be examined.

Numeracy links
Australian Curriculum Outcomes and elaborations—Year 7
Data Representation and interpretation—ACMSP119, ACMSP169, ACMSP171, ACMSP172
Construct displays, including column graphs, dot plots and tables, appropriate for data type, with or without the use of digital technologies.
Identify and investigates issues involving numerical data collected from primary and secondary sources.
Calculate mean, median, mode and range of sets of data. Interpret these statistics in the context of the data.
Describe and interpret data displays using median, mean and range.

Australian Curriculum Subject Outcomes and Elaborations

Outcomes: Acquires and processes geographical information by selecting and using geographical tools for inquiry GE4-7
Communicates geographical information using a variety of strategies
Content:
Value of landscapes and landforms
Students: Investigate the aesthetic, cultural, spiritual, and economic value of landscapes and landforms for people, including Aboriginal and Torres Strait Islander Peoples

The Learning Task—Year 7

- Students: Investigate techniques for collecting data, including census, sampling and observation
- Recognise and explain the difference between a 'population" and a "sample"
- Discuss constraints that may limit the collection of data
- Investigate issues involving primary and secondary data
- Construct appropriate survey questions

Including ATSI perspectives: These students can relate to the value of landscapes both culturally and spiritually however the economic focus of this activity may present issues. There may be different worldviews on the appropriateness of Aboriginal Heritage sites and spiritual places being used to raise tourist revenue. This may raise discussion points that need to be explored with a degree of justice and social equity, not determining right answers. All students are respected for their views and opinions

Strategies to include learners with oral backgrounds: It is possible that these students may have come to Australia as the result of being driven off their land for economic reasons. They also may have difficulty with the notions of tourism and the statistical information that they have to compare and discuss. It may not be possible to achieve all the tasks that contain technology, calculation and the ideas elating to economic land value from tourism. They certainly will be able to draw and indicate the differences in the locations from the pictures on the website. Economic land use may be interpreted as growing crops for survival, or for exchange or for cattle etc.it si important to respect and include all worldviews as valid and appropriate

Authentic Assessment strategies

Authentic assessment is the basis of this activity as students undertake real world investigations into the value of landscapes economically.

Students access, analyse and evaluate tourism and government websites and undertake their own real world sampling. They evaluate and display their findings.

Variations for students from diverse social contexts

Though many students may have experienced life as a tourist, there may be those who have not. Depending on their geographical location, these students may not be familiar with the habits and lifestyle that identifies tourists nor with 'tourist attractions' or frequent, seasonal visitors, especially those from other countries as indicated on the websites. It may be necessary to take time to discuss with these students the whole relationship with geographically diverse places and the reasons people would travel to see them and how these people's daily needs would be accommodated

Geography: Year Seven—Value of Landforms

Resources

1. http://www.planetware.com/tourist-attractions/australia-aus.htm
2. http://www.australian-information-stories.com/australian-tourist-attractions.html
3. http://www.australia.com/en/explore.html
4. http://www.tra.gov.au/documents/ivs/IVS_one_pager_June2015_FINAL.pdf

Introduction

An investigation into the value of landscapes and landforms—cultural, spiritual, aesthetic and economic. Using tourism as the basis for the research, students investigate reasons for valuing landscapes which can be translated into an economic value.

Pedagogical strategies
This activity is investigating the economic value of tourism:

- In small groups, students create a list of the things on which tourists spend money
- Identify the most popular tourist destinations in Australia (site 1 and 2) select two sites and do site analysis to explain the rankings
- Create an agreed upon composite list of 10 most popular sites and use site 3 to locate them on a map.

As a class have each student vote for their favourite tourist destination from the website lists.

- Display the results as a tally sheet and use tally to rank results then compare with website rankings—discuss similarities and variations
- Introduce the concepts of statistical populations and statistical sampling.

As a group, students should investigate each of tourist destinations that have been listed and classify their value as predominantly cultural, spiritual, aesthetic or economic. Record the results in tabular form and then display them as a bar or column graph.

Students remain in their groups to investigate the fourth site—number of tourists and the value of tourism to the Australian economy.

Analyse the statistics on this site by looking at

- What has been measured, the source of the information, rank the sources of tourism by country of origin and by the amount of money spent.
- Introduce the terms maximum, minimum and mean and discuss reasons for any variation between the two rankings. Present these findings accurately as a pie chart.

Complete some basic statistical investigation

- Calculate averages or the mean for tourist numbers and tourist dollars spent and discuss the results and why these calculations are performed.

Student survey—students develop a survey question sheet that should address destinations and spending. Conduct a survey across the Year 7 cohort to determine favourite tourist destinations and reasons (cultural, spiritual, aesthetic) for travel and how and where they think money is spent. Collate these results using the same statistical analysis completed above, graph these results and compare the findings.

Students in their groups select one of these destinations and discuss how tourism could be either good or bad for this location. These results are used for arguing the case for the economic value of landscapes and students should support this argument with the facts they have obtained from website 4.

Teacher References

http://www.tourism.australia.com/statistics.aspx
www.primaryresources.co.uk/maths/…/drawing_bar_charts_correctly.ppt
https://www.mathsisfun.com/data/pie-charts.html
http://www.mathsisfun.com/mean.html

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Gilbert, R., & Hoepper, B. (Eds.). (2014). *Teaching humanities and the social sciences: History, Geography, Economics and Citizenship* (5th ed.). South Melbourne: Cengage Learning Australia.

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Author Biographies

Dr. Debra Donnelly is a history and social science educator in the School of Education at the University of Newcastle, NSW, working in both undergraduate and postgraduate programmes. She has a secondary school background with extensive classroom, school administration and welfare experience across a range of educational settings in NSW and overseas. Debra's research interests centre on the development of global consciousness in an age of ever-increasing access through modern technology.

Margaret Martin is a Geography and Commerce teacher who had a long and successful career in the secondary classroom. She has co-authored textbooks on both junior and senior geography and won a Minister's Award for Excellence in Teaching. For the passed decade, Margaret has worked as a Social Science specialist for the School of Education at the University of Newcastle, NSW.

The Numeracy of Good Health

Maura Sellars and Derek Davidoff

Introduction

The inclusion of health as a school subject has traditionally been a means by which young people are formally educated about appropriate foods, matters of hygiene, building and maintaining relationships, understanding 'self' as a developing individual. However, none of this can be achieved without a highly developed sense of numeracy. This is because all the recommendations related to health matters are the results of scientific findings and statistical applications. The suggested daily intakes of various food items, for example that are recommended for consumption for individuals at diverse stages of life and in the context of different personal health needs are calculated from statistics and data relating to the 'norm' or 'average' of any given group of research participants, and not from in-depth study of individuals and their personal needs. The notion of the 'healthy plate', is a good example of the application of this data as it specifies the size, proportion and balance of the food groups for healthy consumption. Similarly, the duration and type of physical activity recommended for various groups of individuals is based on this magical 'average' which has been statically established and then mathematically calculated to 'burn off' an average number of kilojoules, which are in turn, calculated to equate to specific quantities of identified foods, irrespective of the many differences in the manufacture of the product.

Scientifically grounded medical research has also identified factors which may decrease the potential for optimum health based on data gathered from multiple case studies. These findings have led to significant changes in the ways in which media and marketing messages are constructed and advertised for public consumption. Many of

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these messages fail to advertise the pertinent information about products, instead concentrating on assuring the consumer that potentially harmful substances, particularly sugars and fats are minimally present in food products. Consumers need to have the capacities to think critically about claims such as '99% fat free' for example which is commonly found on lollies, yogurts and other dairy products, which neglecting to indicate the high percentage of sugars and other sweeteners, which have equal if not greater potential to be detrimental to healthy lifestyles. A good understanding of the ways in which this leads to misinterpretation of these foods as 'healthy' requires individuals to have a complex understanding of the mandatory nutritional information provided by law on packaged and processed food item. This is typically presented as average quantities per serving, average quantities per 100 g (even when the serving is more or less than this amount) and the recommended adult daily intake of each food category. All of this information is presented in mathematical terms and requires individual to have strong understandings of mathematical strategies for calculations, competencies in processing the implications of data and the capacities for reasoning and problem solving in relation to what may be consumed as a healthy eating plan for the 'average' adult. It is also important to mathematically calculate the type and duration of physical activity that will be facilitated by the selected diet or will need to be undertaken to counteract poor food choices.

One of the ways in which people have been encouraged to stay healthy and active is to let others do the calculation for them. A huge industry has been developed in the delivery of meals which are balanced nutritionally and portioned exactly to meet the needs of the 'average' person. Many companies have meal variations for individuals suffering from particular health issues, for example diabetics, but again the meal recommendations are based on statistically generated generalisations and not on the needs of the specific consumer. Another recommendation is the resurgence of the benefits of whole foods that have not been processed in any way. This has led to the introduction of programs in schools such as 'Crunch 'n' Sip' and the establishment of school gardens for food production. This recommendation requires a different set of mathematical thinking around time, both duration and elapsed time' and food quality in addition to the critical perspective that is important in all choices related to healthy eating, balance and exercise. While it is certainly correct to state that lettuce, for example, is fat free, sugar free and salt free, it is also important to understand the impact of temperature, freshness and potential chemical contamination and its degree of saturation when interpreting the message that lettuce is a healthy food choice.

Why Is Health in School So Important?

The notions of time and rate of societal change, the influx of information and the development of new ways of processing, storing and preserving food in the technologically dominated regions of the world are important for students to fully understand a very different society from that of 50 years ago. Not only has the pace of life in general increased, habits and customs around food preparation and dietary habits have been, for many families, reserved for special occasions and so students may not have the daily exposure to measuring, estimating, timing and other hitherto customary activities which dominated kitchens in every household. In its place, a range of processed, convenient foods gradually established themselves as part of a new diet that is characterized by (mainly American) fast food chains all over Australia.

While formerly any excess consumption of fats and sugars could be burned off by regular activities such as walking or riding a bicycle to school daily, playing backyard cricket or football or just about any type of physical activity, concerns for student safety, the popularity of sedentary activity associated with personal technological machines and gadgets has placed some Australian children and youth at risk of a number of illness and disorders associated with poor nutrition and lack of exercise. Determining the balance of a healthy diet and exercise routine is not a simple mathematical undertaking and requires complex computational knowledge in addition logical decision-making. The impact of an unhealthy lifestyle also includes the substantial consequences for the students' potential to learn. The brain is the site of all cognition and, like any other body part, it needs to be kept healthy in order to perform optimally. Inadequate nutrition and sleep deprivation can impact negatively on the functioning of the brain in the learning process (Sellars, 2008). Exercise and movement in general not only improve cognition and memory (Sousa, 2010), because of the increase in the flow of blood and fluids to the brain, but also because exercise is strongly correlated with increased brain mass and cell production (McCombs, 2004). Unfortunately, a review of the literature on childhood obesity (Sobal & Stunkard, 1989) provided strong correlation between obese students and low socio-economic status.

Socio-economic status was found to be a key factor in other research related to student health. Low iron levels adversely affect cognition and iron deficiency was more common in students from low socio-economic backgrounds as was the identification of food insufficiency. In comparison the NSW School Physical Activity and Nutrition Survey (SPANS) in 2010 indicated that the rate of obese or overweight children in NSW had risen from one in ten in 1985 to one in four by 2004 (New South Wales Ministry of Health, Department of Education and Communities NSW, & The Heart foundation). Additionally, a more recent report (Sanigorski, Bell, Kremer, & Swinburn, 2007) indicated that more girls were overweight than boys and that low socio-economic status was a key factor in the findings. Educating students in classrooms so that they have the mathematical concepts and competencies to make healthy food choices for themselves must be an educational priority. The following facts sheet about teeth and dental hygiene is an example of how even basic health information about a common human characteristic cannot be understood without the capacities to understand number, sequence, duration and elapsed time, space, position, ratio, percentages and frequency amongst other mathematical concepts.

Facts About Teeth and Oral Hygiene

When a child starts school they will have a combination of primary (deciduous) and secondary (permanent) teeth. Primary teeth start forming when the child is in utero. By the time the child attends school, they usually have 24 teeth. As the child ages, the roots of the primary teeth start to dissolve. The teeth will become loose and fall out naturally. This usually occurs at ages 5–7 years. They are replaced by larger and slightly darker secondary teeth. Secondary (permanent) molars will appear behind the last primary molar at about 6 years (boys are often delayed by 12 months).

Oral Hygiene

Good oral hygiene is essential for keeping the teeth and gums healthy. Everyday care routines are essential for maintaining good oral health and good hygiene. This includes the use of:

1. A proper tooth brush
2. Dental floss
3. An effective toothpaste (fluoride)

Children 5–10 years should brush their teeth twice a day, after meals, for at least 60s. Ten years and over for 90s with flossing once a day and at night after brushing. Brushing will only clean three of the five surfaces of the teeth, flossing and the use of interdental brushes will maintain the other two surfaces. Should the teeth not be cleaned on a regular basis, dental plaque will form on their surfaces. The formation of dental plaque is responsible for:

1. Tooth decay
2. Gum disease (gingivitis).

Dental plaque is a complex, sticky biofilm which adheres to the surface of teeth. It consists of:

(a) Bacteria
(b) Food particles
(c) Bacterial by products.

In dental plaque, bacteria thrive on foods (such as sugars and carbohydrates) producing organic acids (especially lactic acid). These acids then act on the enamel surfaces by dissolving out the calcium and phosphate ions, a process called demineralisation. If the pH of the dental plaque were to go below pH 5.5 (i.e. very acidic), a demineralised white spot lesion will occur. These white spot lesions will 'usually' occur at the gum level or in the fissures at the top of the teeth. Although the surface of enamel is structurally intact, it is more porous. These white spot lesions appear at the gum level in the fissures on the top of the teeth. Further progression of this acid attack will eventually breakdown the integrity of the enamel surface resulting in a cavity. Cavities quickly lead to decay of the enamel and dentine layers of the teeth. Extensive decay will lead to infection in the dental pulp chamber or the infection of the gums, seriously impacting the child's dental health and general health. Prevention of this is easily attained by good oral hygiene.

Diet

The formation of dental plaque is greatly increased by the ingestion of foods high in sugars, acids, or both. The longer the teeth are exposed to plaque, sugar and acid, the higher the probability of decay and enamel erosion. Foods high in sugars will stick to the teeth and not allow saliva to help stop (buffer) the demineralisation process. Similarly, foods high in acid—such as soft drinks (can have a pH 2.45–2.53). This high acid will start to erode and soften the enamel surface very quickly. Some foods are branded as healthy snacks and put into child-friendly boxes. They contain high sugar levels which expose teeth to prolonged acid attack if they are not cleaned effectively. Some examples include muesli bars, processed fruit snacks, fruit cordials and confectionary. Dairy-based fruit snacks are generally lower in sugars and acids, so they have less detrimental effects on dental enamel.

Advice for Snacking

1. Avoid snacking on food high in sugar and high in acid (e.g. soft drinks)
2. Avoid sticky foods high in sugar (muesli bars, processed food snacks and confectionary)
3. Sports drinks are high in acid—drink these in moderation and do not swish them around the mouth (exposes more tooth surfaces to acid)
4. Rinse with plain water after consumption of high acid foods. Do not brush until 60 min after consumption as the enamel will be softened—allow time for the saliva to help buffer and strengthen the enamel
5. Eat fresh produce for snacks, e.g. bananas, melons, almonds as even some apples such as Fujis have high acid levels so rinse with water afterwards
6. Reduce frequency of snacking between meals to help keep the formation of dental plaque to the lowest possible levels.

Teachers and parents can greatly improve the dental health of children. They should encourage:

1. Good oral hygiene habits—brushing twice a day—flossing once a day (at night time after brushing)—the use of fluoride toothpaste
2. Good dietary habits by reducing—foods with high sugars—foods high in acids—frequency of snacking.

These simple steps will greatly benefit all children, especially those without access to regular dental care. Children should be encouraged to recognise that simple plaque removal and diet control will result in good dental health and that these are simple habits worth forming.

Differentiation: This task can be completed with vegetables as the topic or the data can be classified differently. The fruit data can organized as fruit we can eat with the skin or peel on and fruit that we cannot eat with the peel or skin on (apples may come into both categories depending on the students. Can be classified as have many seeds or pips or one large stone, where/ how it grows: bushes, vines, tress etc. these are all ways to classify, read and interpret the data set they make themselves.

Australian Curriculum Mathematics Outcomes

(ACMNA005)

(ACMMG009)

(ACMSP011)

Numeracy Links

* Sort and classify familiar objects and explain the basis for these classifications.

** Sort, describe and name familiar two-dimensional shapes and three-dimensional objects in the environment

*** Answer yes/no questions to collect information

**** using data displays to answer simple questions

Australian Curriculum Subject outcomes and elaborations

Identify actions that promote health, safety and wellbeing (ACPPS006) grouping goods into categories such as food groups and 'always' and 'sometimes' foods (FN)

The Learning Task Foundation: Food that is 'Always Food' – Fruit

Students learn about different fruit, why it is good for them and how it is gown. They also create and interpret data sets with the help of the teacher.

Including ATSI perspectives

Many of these children may have native fruits amongst their fruit choices and may know them by their traditional names. While some of these are well known generally, it may be useful to look at http://www.mcd.com.au/our-range/australian-native-foods and https://en.wikipedia.org/wiki/Bush_tucker

And share with the class

Strategies to include learners with oral backgrounds: many of these students have come from other climates and countries. They also may have native fruits that they identify from their traditional names. It may be useful to research the native fruits of their respective homelands and to put catalogue pictures of commonly bought or grown fruit on flash cards with the English names for class use. The students may engage with the songs and story about fruit from the video and can be encouraged to make their own oral story about the fruit they like. It may be hard to understand food choices and foods that other children will not eat or dislike. This is because having enough food may have been problematic in the past.

Authentic Assessment strategies:

Contributing to the discussion about fruit and making a decision about their personal favourite. Telling why fruit is an 'always ' food

Making simple inferences from the data display

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Variations for students from diverse social contexts: some students may not be accustomed to eating fruit regularly for any number of reasons. The home shopping may not include fresh fruit and there is nowhere to grow it. The students may just eat what they prefer and parent accommodate their choices. The critical role of fruit in the students overall wellbeing, concentration and health may be not well understood by the parents or caregivers and the students have other snacks or perhaps no snacks at all. The introduction of school programmes such as 'Crunch and Sip' have helped to educate students and families.

Conclusion

What students eat, the activities in which they engage and their understandings of basic cleanliness routines that impact on their health and well-being matter a great deal. This is not only in terms of physical fitness, sound body image and the ways in which these support the development of social and personal relationships. Perhaps the major benefit of health education in schools is that it contributes significantly students' sense of well-being and to the potential for all students to engage more effectively with the entire curriculum and improve their learning outcomes. However, for this important area of learning to be meaningful and to have the desired impact on improving students' lives, they must also be educated to be mathematically competent and socially numerate.

Healthy Eating: Foundation

Resources Grid prepared with even spaces for making column chart, small pieces of paper for students to draw fruit (these need to be the same approximate size of the column grid spaces), variety of supermarket advertisements with pictures of fruit, A3 paper to stick cut out pictures on: these can be labelled with the most common fruits, YouTube of fruit rhymes https://www.youtube.com/watch?v=OFkrRdh1YtY.

Naming fruit and understanding that it is healthy—identifying as an 'always' food

Introduction

Discuss the different types of fruit students can identify when they go shopping. Are there any that they like to eat? *Discuss the different types of fruit using categories such as:

- Those where we can eat skin or peel
- Those that have big seeds and those with little seeds or no seeds at all
- Any that students know grow in their garden, grandparents' garden, neighbour's garden, etc.
- Those that grow on trees and those that grow on vines
- Those that grow singly and those that grow in bunches.

**Distribute the supermarket advertising leaflet and ask students to cut out the fruit pictures and choose the correct A3 sheet to stick their fruit on. Students will

Differentiation: The lesson may be developed to include general hygiene such as keeping hands clean, keeping nails clean and keeping their hair clean. There ae various resources to support all of these activities on the internet.

https://www.google.com.au/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=youtube%20hygeine%20for%205yer%20olds

Australian Curriculum Mathematics Outcomes

(ACMMG007)

(ACMNA002)

Numeracy Links

*Compare and order the duration of events using the everyday language of time

** understanding that each object must be counted only once, that the arrangement of objects does not affect how many there are, and that the last number counted answers the 'how many' question

Australian Curriculum Subject outcomes and elaborations

Identify actions that promote health, safety and wellbeing (ACPPS006) understanding the importance of personal hygiene practices, including dental hygiene.

The Learning Task Foundation: Cleaning Teeth

In this lesson the students have opportunities to learn how to clean their teeth themselves properly. They learn about dental health and oral hygiene when not actually cleaning their teeth.

Including ATSI perspectives: Many of these children may have more traditional ways of cleaning teeth that the usual way of toothpaste and toothbrush. There are a number of plants and other coarse matter in a traditional diet that required people to chew vigorously and thus clean their teeth while eating but that has changed with the Western diet that many now consume and dental health has become an issue for many in this group. http://www.nt.gov.au/health/healthdev/health_promotion/bushbook/volume2/chap3/oral.htm

Strategies to include learners with oral backgrounds:

In many Arab and Muslin counties, teeth are cleaning with twigs that are from specific trees and often contain a high percentage of naturally occurring fluoride. Oil pulling is another traditional teeth cleaning method, so it may surprise some of these students to see the videos and other resource materials in this lesson where people are cleaning teeth with a toothbrush and toothpaste. Because this does not happen in their homes, it does not mean these students do not have their teeth cleaned!! See: http://www.mnn.com/health/fitness-well-being/stories/how-the-rest-of-the-world-brushes-their-teeth

Authentic Assessment strategies:

Students: use correct movement to clean teeth effectively with their toothbrush

Can discuss why their teeth need to be clean

Can count their teeth (with very clean fingers) using one to one correspondence

Variations for students from diverse social contexts: in addition to the many traditional ways that people in various social and cultural contexts clean their teeth, there are other considerations around the issue of dental hygiene and decay. People who have never been introduced to processed foods, refined sugars and white flour products can maintain their teeth healthily until they are introduced to these foods. Then they are very susceptible to tooth decay. Additionally, some cultural and societal groups have different perspectives on the entire issue of what is hygienic and what is not when it comes to cleanliness and common practices in Australia. Cultural sensitivity is needed.

have different brochures so there should be a collage of different representations of the same fruit.

Watch the selected sections of the fruit rhymes YouTube video and discuss with the students what they have learned about the selected fruit they saw on the video (the categories above can be used to frame this discussion again).

Introduce some specific language such as vitamin, etc., that is used in the selection of the video chosen to share.

Watch the video selection again, asking students to pay particular attention to the fruit they like best from the selection. The students are looking for why their favourite fruit from those shown is good for them.

Distribute the small paper pieces and ask the students to draw and colour their favourite fruit and then stick it on graph in the correct column, inside the gird lines (with assistance if required).

As the students complete this task, they go and sit with the other students who chose the same fruit. ****In these small groups, the students discuss what they learned about their healthy fruit. Each 'fruit group' can report to the class about what they learned. Depending on the students' competencies, they can talk about their fruit, make a poster/picture with some words or maybe check a list with their name and the name of their fruit on top. ***They can choose yes or no for statements like these.

- I eat the peel
- My fruit has seeds
- My fruit has vitamin C
- My fruit has vitamin A
- My fruit grows in trees
- I know that my fruit ______________________________.

Dental Health: Foundation

Resources https://www.youtube.com/watch?v=hDZXSMU2lAk https://www.youtube.com/watch?v=Tao7uuEFi_Y http://freebies.offermatch.com.au/ipad?affiliate_id=google&aff_sub=hunt4freebies.com|78016678844|c&aff_sub3=

hunt4freebies.com|78016678844|c&gclid=CP2U-v2eqMkCFQF_vQodRnEFUg (free toothbrushes and toothpaste and teacher kit from Colgate) strips if paper divided in four sections, colouring pencils, timer, large pictures of a dentist, teeth, toothbrush and toothpaste if available.

Teacher Background Information. Toothpaste with fluoride is not recommended for children under 6 years with some authorities questioning the long-term safety of having fluoride as an ingredient in toothpaste at all. Eating cheese is often now recommended from some experts as it makes the saliva less corrosive than fresh fruit snacks. There is also some debate as to whether teeth should be cleaned before and after eating and if people should rinse away the toothpaste after cleaning to maintain best possible protection. **Discuss**: how are our teeth kept healthy? Questions might include:

- Has anyone been to the dentists?
- Does anyone know a dentist?
- What does a dentist do?
- How does he tell if your teeth are healthy or not?
- What do you have to do at the dentists?
- What might happen if the dentist thinks there is something wrong?
- How do we keep our teeth clean at home?
- Why would we do that?
- How do you clean your teeth?
- How can you keep your teeth clean after you have lunch at school? Watch the YouTube video about cleaning your teeth and sing the teeth cleaning song.

- ***Task**: students sequence **four things they do in the morning before they come to school. Draw on the long strips of paper, one action in each box (i) Ensure that cleaning teeth is one of these things students do in the morning (ii) When are the teeth cleaned in the sequence of activities?
- Check that the students are cleaning their teeth after they eat

- *The students can turn the paper over and sequence **four activities that they do before going to bed at night. Again, check they do not place the teeth cleaning after a snack or a drink of juice or milk. Practice the procedure for cleaning teeth from the video and ensure that it lasts for 2 min so the students get an idea of the duration of the brushing (use the free samples from the Colgate Teaches' Kit for this)
- Discuss with the students; What else can we do if:
  - We stay over at a friend's house and we forgot to pack our toothbrush?
  - We are out camping and there is no bathroom for cleaning teeth?
  - Your brother or sister takes too long in the bathroom and you have to run for the bus without cleaning your teeth?
  - Someone uses all the kid's toothpaste and there is none left for you?
- Discuss and list all the suggestions that the students offer as alternatives for cleaning teeth. These should include drinking water amongst the many different ideas that students offer.

The Learning Task Year One – Healthy Eating

In this lesson the students have opportunities to learn about the benefits of eating raw and cooked whole foods in preference to eating processed foods.

Differentiation: The lesson may be developed to include an investigation of what is a whole food that students may eat regularly and what is a processed food. The students may benefit from a trip to the supermarket to identify these two food options o from the shelves and displays or from the teacher binging a week's shopping to school for classification and discussion. The students may also make a list of what they have in a salad at home (including the items they may not eat) and why they like/dislike some of the ingredients.

Australian Curriculum Mathematics Outcomes (ACMMG022)

(ACMMG019)

(ACMSP262)

Numeracy Links

* Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features

** Measure and compare the lengths and capacities of pairs of objects using uniform informal units

*** determining which questions will gather appropriate responses for a simple investigation

Australian Curriculum Subject outcomes and elaborations:
Recognise situations and opportunities to promote health, safety and wellbeing(ACPPS018) exploring how eating healthy foods can influence health and wellbeing (FN)

Including ATSI perspectives: Although many of the bush tucker foods are familiar to almost everyone now, with some actually being gown as commercial crops, it is important to include the suggestions that these students offer about native plants that ae edible and traditionally included in the diet although they may not be classified as 'salad' http://www.mbantua.com.au/bush-tucker/bush-tucker/bush-tucker/bush-tucker/
These can be shared as a class

Strategies to include learners with oral backgrounds: The notion of 'salad' may be very foreign to many of these students, not only because of the shortage of food and experiences of hunger but also because the fresh ingredients of this dish needs lots of water to grow, are not easily preserved and do not store well, so they may not feature in any traditional diet in a major way. Also, many of the ingredients are not grown in desert climates and may not be to the taste of the students who have not been given them as a food option (and others who have!). A display of various green vegetables and salad ingredients may support all students in the class who may be unfamiliar with these ingredients. http://strategyleader.org/profiles/dinka.html

Authentic Assessment strategies:

Can the students discuss food that are healthy and those that are not?

Can they measure and compare the growth of the cress heads using the paddle pop stick as an informal marker?

Can students identify whole food from, processed food in their sandwich?

Variations for students from diverse social contexts: While almost all cultures and peoples have their own version of salad depending on their climate, many will not resemble the green salad so popular in Australia. Many salads in different parts of the world have cooked or preserved vegetables as their basic ingredient and many incorporate grains, nuts and seeds. In addition to the various understanding of salad, there are social considerations about eating salad and some students may belong to families where salad is not eaten at all for economic or reasons of personal preference or taste. For some other students it is not 'cool' to eat greens of any sort!

Healthy Eating: Year One

Resources Small paper for drawing or supermarket advertisements illustrating green salad items and green vegetables or food magazines for cutting up, eggs, kitchen roll, cress seeds, cotton wool, textas for drawing on the eggshells, Smart BoardCress egg heads instructions from http://www.greatgrubclub.com/cress-egg-heads#.VkFFy7crLVY.

Introduction

Discuss with the students the idea of healthy. Ask what people might eat to be healthy. Make a list of all the green fruit and vegetables that are mentioned. Ask the students about green salad. Questions might be as follows:

- What could you have in a green salad?
- Who eats the most salad in your home?
- Who does not like salad? Collect reasons
- What can you have instead of salad?
- Who grows any of the salad ingredients in their garden?
- Why would you eat salad? Discuss the lack of fats and sugars and the vitamin content.

Depending on the resources, students can then *draw, identify and cut out all the green salad ingredients to make a poster of green healthy food. The poster can be collage, a vegetable display that could be seen in a supermarket or any type of organisation that the students suggest. Integrate some key words that the students have used in the discussion about being healthy and in responding to the questions in the introduction. The poster should have a title. Something like ‘green is good on your plate’ or ‘salad is special’ that emphasises the healthy aspect of eating green vegetables.

Go to the web page on the Smart Board and discuss what you are going to do next (the eggs can be cracked and cleaned in advance if that is more appropriate for your students). Distribute the eggshells, the kitchen paper and cotton wool. Have several small containers of water at various parts of the room so all the students have access without being too crowded. When the eggshells are all assembled, the cress seeds can be sown in them, placed in the egg container for safety and stored on the windowsill so that the seeds get some light.

These seeds will grow quickly and the students will be able to see them getting taller above the top of the eggshell. **With a partner, use a paddle pop stick to measure and compare the height of the two cress heads. Mark the height of both on the paddle pop sticks. This is when the students may like to gently draw faces on their cress egg with soft textas. When the cress has grown and is showing the green tops, the cress eggs can

Differentiation: Any calendar (or record) can be made of the students who have wobbly teeth or have gaps because of lost teeth. There can be a list of names of students of with wobbly teeth and a record of how long it took for the tooth to fall out. Another chart can be developed that shows the names of the students who have a gap and the length of time it took for the first sign of the adult tooth to appear and then how long it took to come down completely.

Australian Curriculum Mathematics Outcomes

(ACMMG041)

Numeracy Links

*Use a calendar to identify the date and determine the number of days in each month using calendars to locate specific information, such as finding a given date on a calendar and saying what day it is, and identifying personally specific days

Australian Curriculum Subject outcomes and elaborations:
Describe physical and social changes that occur as children grow older and discuss how family and community acknowledge these(ACPPS016) describing changes in their physical appearance now compared to when they were younger (RS)

The Learning Task Years One and Two–Dental Health

In this lesson the students have opportunities to learn about milk teeth and their purpose and discuss what is happening when teeth get wobbly and when new teeth arrive in their place.

ATSI considerations:

These students may have traditional family ways of acknowledging this 'rite of passage' but in general all students will have a similar developmental profile unless there are medical concerns.

Strategies to support learners with oral backgrounds:

These students may have traditional family ways of acknowledging this 'rite of passage' but in general all students will have a similar developmental profile unless there are medical concerns.

Authentic Assessment strategies:

Can the students discuss food that are healthy and those that are not?

Can they measure and compare the growth of the cress heads using the paddle pop stick as an informal marker?

Can students identify whole food from, processed food in their sandwich?

Variations for students from diverse social contexts: As the development profile is similar, irrespective of culture and social background (barring any medical condition), the main are of difference to be considered is about the cultural ways of acknowledging these changes. Some students may never have heard of the 'Tooth Fairy' or have been told by their parents that there is no such thing. Other students may believe but their tooth fairy may leave a tiny amount of money compared to other children's tooth fairy. This can be a minefield of disillusionment and distress unless treated carefully. Different groups may have different opinions.

be given a ‘haircut’ and the cress used to assemble a sandwich made with wholemeal bread. During the growing period, the cotton wool and kitchen paper must be kept damp and not allowed to dry out. The planting may be best organised for the beginning of the week. The discussion that may follow the eating of the cess sandwiches may include suggestions about what could be grown next in the classroom, what did the seed need to grow, and which of the five senses did the students use to determine if they liked the taste of the cress or not. ***Questions might include:

- Did you enjoy the taste of the cress in your sandwich?
- What else could you put in a sandwich with cress to make it tastier? Put suggestions in two groups, healthy and not healthy. Then divide the healthy group into green and not green.
- Students can draw their sandwich and a smiley face (or not!) and write a sentence about their cress sandwich experiences.

Dental Health: Years One and Two

Resources https://www.youtube.com/watch?v=9EME5fbSML0 https://www.youtube.com/watch?v=7MN-sDwPihE http://www.oralanswers.com/the-differences-between-baby-teeth-and-permanent-teeth/ http://www.eschooltoday.com/tooth-care-for-children/tooth-care-tips-for-kids.html this website may be difficult for students to look at alone so showing in the Smart Board with guidance may be best depending on your students. Alternatively, a facts sheet and questions may be usefully developed from this site.http://freebies.offermatch.com.au/ipad?affiliate_id=google&aff_sub=hunt4freebies.com|78016678844|c&aff_sub3=hunt4freebies.com|78016678844|c&gclid=CP2U-v2eqMkCFQF_vQodRnEFUg (free toothbrushes and toothpaste and teacher kit from Colgate)http://teacher.scholastic.com/products/face/pdf/my-books/sample-activity-sheet.pdf Magic School bus and the missing tooth, copies of the questions if requiredhttps://www.responsiveclassroom.org/blog/group-activity-idea-lost-tooth-poem, copies of the poem for children to learn if requiredPaper (all the same size, square pieces are best) and colouring in materials for self-portraits. Rolls of strong, wide, cheap sticky tape or masking tape.

Discuss: *Does anyone know someone with a missing tooth? Or a wobbly tooth? Questions might include:

- How did your/your sibling’s/friend’s tooth fall out?
- Why did it fall out?
- Will they all fall out?

Differentiation: Almost any form of advertising can be used to develop the critical skills of the students about food or about marketing in general.

The product may be altered to form a banner or other type of visual display for mapping or the students could make up a song or a jingle themselves and draw a large advertisement to accompany it.

Australian Curriculum Mathematics

WM Reasoning

(ACMMG044)

Numeracy Links

*using known facts to make meaning of information given

** understanding that we use representations of objects and their positions, such as on maps, to allow us to receive and give directions and to describe place

Australian Curriculum Subject outcomes and elaborations: **Examine health messages** and how they relate to health decisions and behaviours(ACPPS021) identifying popular health slogans and discussing the behaviours these slogans are encouraging (FN, S, AD)creating their own positive health message and sharing it with the class (HBPA, S, AD, FN)

The Learning Task Year Two–Healthy Eating - food advertising This lesson requires the students to think critically about the messages that are sent in the media bout certain types of food. It encourages them to make decisions about their food choices and provides opportunities to explore how grids work in a personally relevant manner.

Including ATSI perspectives: The class may prefer to compare traditional foods and diets (bush tucker) with the less wholesome options provided by some of the western influences in food choices. http://www.mbantua.com.au/bush-tucker/bush-tucker/bush-tucker/bush-tucker/ They may also like to share more traditional ways of mapping and describing location.

Strategies to include learners with oral backgrounds:

Depending on their English language competencies, these students may need help to uncover the subtle messages and meanings in the jingles and slogans. They may have traditional ways of indicating places on maps to share. The class may also like to compare the Western diet with the traditional diet of these students.

Authentic Assessment strategies:

Can the students interpret the messages in the jingles?

Do they allow these message to influence their healthy choices?

Can the students successfully describe the pathway to and the map referencing positions of their piece of work on the quilt?

Variations for students from diverse social contexts:

Some students may regard advertising in a negative light, others may really enjoy it or have connections to advertising companies. Be prepared for differences of opinion as students of this age may still be reliant on the opinions of their parents and families.

- Will they fall out all at once?
- Do everyone's teeth fall out?
- What happens to big space left by the missing tooth?

Task: Read the missing tooth poem twice through. The first time without and the second time with the actions suggested. Ask students to make some actions for the third reading. Suggest anyone with a missing or wobbly tooth might like to share their actions with the class. The magic bus and the missing tooth is the easiest webpage for students to share, it has a number of questions that students may answer orally or if you choose, as a group with answers written on the recording sheet. Discuss the answers and if everyone has the same information or not.

- Watch the YouTube video of your choice about the ways in which teeth are constructed, milk teeth and adult teeth.
- Students draw a large picture of their face on paper. They should be smiling and showing all their front teeth, top and bottom (they may need to count their teeth as they smile so washing hands before this activity or using hand cleanser gel may be appropriate).
- Students with missing front teeth can colour in the space with a black pencil to show up the gap—names of students are recoded on the front of the picture.
- Collect all the portraits and when the students have left the room, lay them all face down, checking that are all the same way up to make a big picture with no gaps or overlaps.
- Tape the pictures together, double taping the edges to make a 'quilt'. As students lose a tooth, they can access their self-portrait on the quilt and colour in the gap where the tooth was in order to make the space.
- **Start the calendar of the loose tooth, the gap, the new tooth etc. and read and record how many days there was in between each of the stages.

Healthy Eating: Year Two Food Choices

Resources advertising and special offers material from fast food outlets, magazines, supermarkets, recording of common food jingles and slogans from television advertisements, Smart Board, half sized A4 paper (portrait) for students' healthy slogans, cheap, thick masking tape, long pieces of paper for students' comments on the advertising that they are watching/reading about. Facts sheets for the teacher about common, popular products: maybe McDonalds, Coke, chocolate, vegemite, whatever is the most likely to be popular amongst the products advertised during the lesson.

Differentiation: Using the healthy party options, students may be able to make a 'lunch box wish list' and contribute this data to another graphing exercise. They can also do the same for Christmas or other religious and cultural celebrations.

Australian Curriculum Mathematics Outcomes

(ACMSP068)

(ACMSP069)

(ACMSP070)

Numeracy Links

* Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording

** Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies

***comparing various student-generated data representations and describing their similarities and differences

Australian Curriculum Subject outcomes and elaborations:

Identify and practise strategies to promote health, safety and wellbeing (ACPPS036) eexamining their own eating patterns by researching *The Australian Guide to Healthy Eating* and identifying healthier food choices (FN)

Learning Task: Year Three – Healthy Choices- the Healthy Party

This task requires students to research, select food and design a healthy party. They will need to use their skills with technology, tally, and design a graph showing the results of their inquiry. They will then interpret their findings.

Including ATSI perspectives: The class s may prefer to compare their traditional foods and diets (bush tucker) which were eaten at ceremonies and celebrations with the less wholesome options provided by the western influences in food choices. http://www.mbantua.com.au/bush-tucker/bush-tucker/bush-tucker/bush-tucker/

Strategies to include learners with oral backgrounds: Many of these children may not have been to parties and have not experienced the traditional celebrations that were characteristic of the way of life in their (or their parents') original homelands. They may wish instead to describe what they would like to have for a celebration where people eat and drink together.

Authentic Assessment strategies:

Are the students able to:

Design a healthy party/celebration?

Decide on questions to ask peers?

Collate data and represent visually in a column graph and other display?

Identify healthy and unhealthy party food?

Variations for students from diverse social contexts: There may be considerable differences of opinion about the provision of party food that frequently includes fairy bread, coke cola and other fizzy drinks, cake, lollies, meat pies and sausage rolls etc. some students may think this is the only way to identify a party and others may think that they prefer the healthy party food idea or a bit of both.

Introduction

*Discuss advertising with class. Questions may be:

- Why do food companies and other people advertise their products?
- Do they always tell you everything about their product in the advertisements? Give reasons for answers. Make a note of student responses
- How do different companies advertise their product? (always with nice looking children, models, other items that are socially and culturally appropriate and modern, trendy, up to date etc.).

Watch or listen to some of the jingles and frequently played advertisements that students may be familiar with or distribute the paper copies of the advertising leaflets, magazines or special offers. In pairs or small groups, ask students to discuss the messages that they received as part of the advertising, then individually write a short comment about one of the advertisements indicating what they believed the advertisement message was asking or telling them to do/choose/believe.

Place the long comment strips around the room and give students a few minutes to look at each other's comments. Bring class back together and discuss the comments. The themes could focus on these ideas:

- Are the food or drink choices as good as the advertisements say they are?
- Why would people choose these products if they know that they are not as good as the advertisements make them sound?
- Is there anything that the advertisements don't tell you about the food or drink?
- Why would they not tell all the facts about the product?

Ask students to draw themselves and write a sentence that encouraged healthy choices on their half A4 paper.

When these are all completed (after school ideally), lay all the pictures flat on the floor, face down (check that they are all the same way up so that they can be read) and tape together at the back. Tape double lengths of tape along all the sides (the shape with be determined by the number of students in the activity) and reveal the 'Healthy Quilt' the following day so the students can find their own contribution and share the wok of the others. **Quilts of equally sized pieces can also be used to practice mapping coordinates with students naming the position of their work on the quilt.

Healthy Eating: Year Three What Is a Healthy Choice?

Resources http://www.taste.com.au/recipes/collections/kids+party+food http://www.kidspot.com.au/MySpot-healthy-eating-Healthy-party-food-ideas-for-kids+3522+267+article.htm http://www.jamieoliver.com/news-and-features/features/healthy-party-food-for-kids/#lL5PKWsCu7aifqAd.97 food advertising from supermarkets, food pictures from magazines, enough printed pages from the websites to give students choices or iPads with the web pages loaded so students can return to the pages and cut and paste their selections, small pieces of paper the same size for graphing.

*Discuss the foods that can be seen on the web pages with the students as you look at and explain the web pages above: Questions may be the following:

- Why would that treat be healthy?
- What might your favourite things be to eat or drink?
- Can you have healthy chocolate?
- Can you have a party without lollies?
- What could you put into the lolly bags?
- What sort of food are these web pages trying to avoid?
- What did you have at your party that you cannot see on the webpage?
- Did you have any of the food that you can see at your party?

Task: *students

- Look at the pictures of healthy food (iPads or food illustrations)
- Investigate some of the basic ingredients that look the most appealing to them
- Discuss parties they have been to in the past and what they ate and drank
- In pairs or small groups select six things to eat and two dinks that they would like as party food
- Make their menus into a poster that is aimed to ‘sell’ the healthy choices to their peers
- All the food and drinks need to be labelled so the other students know what is on the menus
- After completion, students can vote for the best and healthiest menu
- Using tallying, record the results and collate as a graph, table or chart manually or digitally to make a visual display entitled ‘healthy party food and drinks’

- Predict the foods and drinks that may be most popular at parties the students have gone to in the past
- Write or draw and label any foods and drinks that they had eaten and drunk at a party in the past on small pieces of paper
- **Make the graph as a column graph and if possible, record as a pictogram (or other visual information format) entitled 'Parties we have been to'
- ***Select the healthy foods from the 'Parties we have been to' graph
- Give reasons for the nominations
- Discuss any that students do not agree upon
- Display the graphs in the room with the healthy party food and drinks on the 'Parties we have been to circled or highlighted in colour to show the students' choices.

Differentiation: The students are able to design a menu from the healthy eating guide for any occasion and for as many people as they would like to invite. They can then cost the menu for the number of people they have invited. Alternately, they can cost their lunchbox contents for a week or a fortnight, cost the family evening meal for a week or any variation that they choose. All menus must be healthy.

Australian Curriculum Mathematics Outcomes

(ACMSP096)

(ACMNA080)

Numeracy Links

***Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values

**Solve problems involving purchases and the calculation of change to the nearest five cents with and without digital technologies

Australian Curriculum Subject outcomes and elaborations:

Discuss and interpret health inf ormation and messages in the media and internet(ACPPS039) examining health messages from different sources and exploring choices, behaviours and outcomes conveyed in these messages.(MH, FN, RS, S, HBPA, AD)

Learning Task: Year Four – Healthy Eating- Investigating 'The Australian Guide to Healthy Eating' This task requires students to research, select healthy food and then compare what they have actually eaten in comparison to the healthy eating guide. The students then cost how much it takes to replace their unhealthy items with healthy ones.

ATSI considerations: These students may prefer to compare their traditional foods and diets (bush tucker) which were eaten at ceremonies and celebrations with the less wholesome options provided by the western influences in food choices. http://www.mbantua.com.au/bush-tucker/bush-tucker/bush-tucker/bush-tucker/

Strategies to support learners with oral backgrounds: These students may need assistance with the technology, the Australian monetary system and with finding their preferred options in food as many of the supermarkets may not stock their exact choices or it may be known by another name. It may be useful to allow these students to draw and describe their food orally in their food diaries, depending on their written language skills.

Authentic Assessment strategies:

Are the students able to:

Collate a food diary for a week (true or not!)?

Identify all the foods as healthy or not from the guide to healthy eating, remembering that some foods are healthy in moderation?

Effectively and accurately find the cost of replacing some of thei unhealthy foods with healthier options?

Variations for students from diverse social contexts: Asking students to describe, explain or make decisions about the food they have eaten in the last week may be considered by some groups to be invasive of their privacy. It may also be an issue to indicate that some foods are not healthy, especially if the dairy is indicative of the family's usual eating habits. This may be considered by some cultural and social groups as a value judgement on their child rearing and general lifestyle. It may be wise to monitor the conversations and peer comments.

Healthy Eating: Year 4. Investigating 'The Australian Guide to Healthy Eating'

Resources http://www.healthyfoodguide.com.au/ https://www.healthyactivekids.com.au/teachers/portion-plate-teacher/ https://www.healthyactivekids.com.au/kids/healthy-eating-plate/ https://www.woolworths.com.au/?gclid=CMXUs8rapckCFcaWvQodPO0HrQ http://shop.coles.com.au/online/national/info/click-and-collect-10-off?gclid=CJedg-TapckCFYKWvAod338FGw&KEYWORD=+online%20+grocery%20+shopping&MATCHTYPE=Search&AD_ID=91627246807&REFFER= class iPads with this link loaded, paper and pencils for recording and making a food diary, photographs or drawn pictures of each individual student in the class.

Discuss the idea of eating healthily and give reasons why this may be an important thing to do. Watch the video on the healthy plate link and discuss. Identify and discuss the five food groups including a mention of the nutritional quality of each group being important.

Task: students

- Create a food diary and record what they have eaten over the previous week (or start the diary in advance so you have a week's worth of food intake to analyse)
- Go to the link above and click on recipes (there are lots to investigate if they scroll down the page and investigate the different categories)
- Decide which of the healthy choices each person would like to try and give reasons. Record this selection or selections
- Look at the previous week's food diary and select the healthiest meal(s) that they have eaten during the past week
- Give reasons for their selection
- Find the least healthy meal they have eaten and replace it with their selection of what they would like to try from the healthy food site
- Gradually work their way through their previous weeks' meals, replacing them with their choices from the healthy food webpage
- Determine if the selected replacements are suitable for the meals they have replaced (for example the students may have selected dessert menus for breakfast, lunch, dinner and snacks!)
- *On their page/poster paper/A4 sheet of paper students can draw or stick a picture of themselves and beside it describe and draw (or copy, paste and print the web illustrations and titles) the food choices that they would like to have for one day, making a data display of their choice
- These food selections should be balanced in terms of variety of foods from the major food groups (the students can go to the healthy food webpage and look under resources to find out more about healthy eating)
- **Use the shopping links to estimate an approximate cost for the day's menu and add this to their poster, giving the amount of change they would receive from a given amount of money.

The Learning Task Year Five and Six Investigating Healthy Lifestyles In this lesson the students have multiple opportunities to view healthy foods. They keep a healthy lifestyle diary and investigate some experiments conducted on McDonalds foods to explore the ingredients that are used in comparison to other food outlets

Differentiation: The lesson can be focussed on other fast food outlets with the actually food and rate of decay being charted by the students themselves and developed as a time lapse video. Any fast food product can be compared to similarly prepared food from fresh food outlets. The different components of a burger for example can be placed in different jars that are clearly labelled and the timeline of decay recorded for different food groups. The ways in which large supermarkets store and spray fresh foods can also be explored in order to establish exactly how fresh the fresh foods actually are.

Australian Curriculum Mathematics Outcomes

(ACMSP116)

(ACMSP119)

Numeracy Links

* List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions

**Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies

*** identifying the best methods of presenting data to illustrate the results of investigations and justifying the choice of representations

Australian Curriculum Subject outcomes and elaborations: Investigate the role of preventive health in promoting and maintaining health, safety and wellbeing for individuals and their communities(ACPPS058) investigating practices that help promote and maintain health and wellbeing, such as eating a diet reflecting *The Australian Guide to Healthy Eating*,

Including ATSI perspectives: the class may wish to include some bush tucker items into the experiment-these could be the genuinely freshest ingredients around, apart from those picked from home and school gardens. Investigations may also be made into the nutritional value of bush tucker compared with other foods in the experiments. http://www.indigenousaustralia.info/food.html

Strategies to include learners with oral backgrounds: the notion of wasting food, however lacking in nutrition, may be confrontational for some of these students as their experiences may have included hunger, rationing and concerns relating to sufficient food to survive. However, the establishment of the Mc Donald's chain in almost every town and suburb of Australia could easily mean that they have had some experience of this type of food consumption. This needs to investigated as a part of a healthy lifestyle. The notion of lifestyle itself may need additional support to be conceptually understood (for example, the Dinka were originally nomadic people). This is best done by including narrative and performance

Authentic Assessment strategies: Can the students draw some appropriate conclusions from the experiment in the video? Can the students reflect realistically and critically on their own lifestyle as recorded in their diaries? Can the students use the ingredients data and other data to construct a Venn diagram (or similar) and a histogram or other visual display that suits the data collected? Can they justify their choice?

Variations for students from diverse social contexts:

Investigating food from a cheap, well known outlet like McDonalds may be confrontational for some students for a variety of reasons. It may form part of their regular diet at home, it may be the place where special celebrations ae held for the family (birthdays etc), it may be a treat that parents allow their children or it may be where they spend their pocket money without their parents' knowledge. It would be unusual for students not to have ever had a McDonald's experience so the resources are forcing students to question their lifestyle choices-even if it an affordable meal and no one in the family cooks or shops for fresh food

Healthy Eating: Years 5/6 Investigating Healthy Lifestyles

Resources https://www.youtube.com/watch?v=MhOOacGb1_c https://www.youtube.com/watch?v=gu46YwVrzvkhttps://www.healthykids.nsw.gov.au/teachers-childcare/healthy-lifestyle-programs-for-primary-schools.aspx http://www.healthykids.nsw.gov.au/teachers-childcare/live-life-well-@-school.aspx class set of iPads or computers, weekly planner, paper for Venn diagrams http://www.livestrong.com/article/369845-what-are-the-benefits-of-a-healthy-lifestyle-in-school/http://www.healthykids.nsw.gov.au/kids-teens.aspxhttps://www.youtube.com/watch?v=0oo0r800sNM (how to make a Venn diagram in Excel) https://support.office.com/en-us/article/Create-a-Venn-diagram-d746a2ce-ed61-47a7-93fe-7c101940839d teacher resourcehttp://pbskids.org/itsmylife/school/time/article6.html (make a weekly planner for kids).

Discuss: What is included in a Healthy lifestyle for this age group. Questions might include the following:

- What is meant by lifestyle?
- Why might schools have crunch and sip programmes?
- What sort of things might interfere with a healthy lifestyle?
- Why are various foods considered healthy and others not?
- What is the importance of drinking water?
- Do snacks count in healthy lifestyles?
- Is it important that you choose what you drink?
- What is important about being active?

Watch the YouTube videos about a healthy plate and a healthy breakfast: *follow up by discussing chance questions before viewing results of the video about McDonald's and other similar foods and preservatives.

Discuss: questions might include the following:

- What are the common ingredients in the healthy plate and the McDonalds' food featured in the experiment?
- Why did the foods start to deteriorate at different rates?
- What are the implications of the experiment for both types of foods? What conclusions could you draw from what occurred?
- How could you tell if you were eating fries that were ten weeks old? They look the same!
- Why was the food from the other outlets deteriorating in different ways from the McDonald's food?

Task: using the iPads or computers, students revisit the healthy plate webpage and re-watch the YouTube video about the food deterioration.

Differentiation: There are a number of options for this task all embedded in the lesson(s). There are options for making and using the tooth pastes and powders of the students' choice and opportunities for students to explain alternative approaches to oral hygiene that are linked to cultural or traditional customs or personal health choices they and their families have made. There may be discussion and exploration of the unwanted effects of fluoride in manufactured toothpastes and the reasons why many people; avoid them altogether.

Australian Curriculum Mathematics Outcomes

(ACMSP116)

(ACMSP147)

Numeracy Links

* List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions

** Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables

*** compare different student-generated diagrams, tables and graphs, describing their similarities and differences and commenting on the usefulness of each representation for interpreting the data

Australian Curriculum Subject outcomes and elaborations: Investigate the role of preventive health in promoting and maintaining health, safety and wellbeing for individuals and their communities(ACPPS058) investigating practices that help promote and maintain health and wellbeing,

The Learning Task Year Five and Year Six – Dental and Oral Hygiene

In this lesson the various cultural and traditional ways of cleaning teeth and of oral hygiene are explored. Alternative tooth cleaners, including paste and powder are explored and can be made as part of the lesson.

Including ATSI perspectives: Many of these students may have more traditional ways of cleaning teeth that the usual way of toothpaste and toothbrush. There are a number of plants and other coarse matter in a traditional diet that required people to chew vigorously and thus clean their teeth while eating but that has changed with the Western diet that many now consume and dental health has become an issue for many in this group and others http://www.nt.gov.au/health/healthdev/health_promotion/bushbook/volume2/chap3/oral.htm

Strategies to include learners with oral backgrounds: In many Arab and Muslin counties, teeth are cleaning with twigs that are from specific trees and often contain a high percentage of naturally occurring fluoride. Oil pulling is another traditional teeth cleaning method, so it may surprise some of these students to see the videos and other resource materials in this lesson where people are cleaning teeth with a toothbrush and toothpaste. Because this does not happen in their homes, it does not mean these students do not clean their teeth. See: http://www.mnn.com/health/fitness-well-being/stories/how-the-rest-of-the-world-brushes-their-teeth

Authentic Assessment strategies:

Can students communicate an understanding of the implications of oral hygiene and appreciate that different cultural traditions used various different methods of cleaning teeth and maintaining oral health? Can the students generate graphs, charts, diagrams and tables to present data, explain their similarities and differences and justify their choices?

Variations for students from diverse social contexts: : in addition to the many traditional ways that people in various social and cultural contexts clean their teeth, there are other considerations around the issue of dental hygiene and decay. People who have never been introduced to processed foods, refined sugars and white flour products can maintain their teeth healthily until they are introduced to these foods. Then they are very susceptible to tooth decay. Additionally, some cultural and societal groups have different perspectives on the entire issue of what is hygienic and what is not. When it comes to cleanliness and common practices in Australia, cultural sensitivity is needed.

- In groups or pairs, identify the ingredients that are the same in both the Mc Donalds' food and the fresh food
- Explain why the food deteriorated differently
- What are the implications of eating McDonalds for a healthy lifestyle?
- Start the food and exercise diary and keep recording for at least a week
- Tally the different sports and activities that mean students have to get up and move around
- **Graph the activities that your class has engaged with over the past week, making a histogram or other type of graph, discuss choice and ***interpret the results, developing a report.

Dental Health: Year 5/6

Resources http://www.wikihow.com/Brush-Teeth-Without-Toothpaste sufficient supplies of the ingredients for the class to make all three of the recipes in groups orb for the selected recipe for the entire class, iPads or computers for researching the toothpaste ingredients and so the students have access to the recipes and to the method to make the alternatives to toothpaste, sufficient toothbrushes for class to try out the recipes. Paper (grid paper is best) and writing materials for rating the recipes and collecting the datahttp://freebies.offermatch.com.au/ipad?affiliate_id=google&aff_sub=hunt4freebies.com|78016678844|c&aff_sub3=hunt4freebies.com|78016678844|c&gclid=CP2U-v2eqMkCFQF_vQodRnEFUg (free toothbrushes and toothpaste and teacher kit from Colgate) https://en.wikipedia.org/wiki/Toothpaste#Herbal_and_natural_toothpastes, prices of the ingredients supplied, plastic tablespoons and teaspoons other kitchen equipment depending on the recipe selection and supervision options. Water bottles for mouth rinsing, buckets (or garden beds) for rinsing water disposal.http://www.excel-easy.com/data-analysis/charts.htm http://www.wikihow.com/Create-a-Graph-in-Excel.

Discuss the advertising material that students have seen in magazines and in television about toothpastes. Questions might include the following:

- What is the message that you get about the toothpaste brand?
- What sort of people are featured in the advertisements?
- *Do you think that everyone will automatically get the results that are promised?
- *Why/why not?
- Why does the dentist not show his face in one advertisement when he is recommending a certain brand of toothpaste?

Task: Read the ingredients in the Colgate samples and, in groups, take an ingredient and research it on the iPads or computers. Save the results so that they can

The Learning Task Year Seven and Year Eight– Nutrition and Preservatives

This activity is designed to make students aware of nutritional values and preservatives in common foods. It involves the students in understanding the nutritional information labels on all food that is not fresh or is processed and packaged.

Differentiation: Students can bring in the packaging from their favourite treat, chocolate bars lollies, chips and other foods and drinks that they have consumed recently and use those for analysis. They can keep an food diary of the food they buy and the food that they have from home and compare the nutritional values. They can compare the nutritional value of tinned or processed fruit with that of fresh fruit. They can compare the same product produced by different companies to establish the similarities and differences and to examine the nutritional value of each.

Australian Curriculum Mathematics Outcomes

(ACMNA155)

Numeracy Links

*Express one quantity as a fraction of another, with and without the use of digital technologies using authentic examples for the quantities to be expressed and understanding the reasons for the calculations

Australian Curriculum Subject outcomes and elaborations: Plan and use health practices, behaviours and resources o enhance health, safety and wellbeing of their communities (ACPPS077) investigating food-serving recommendations from *The Australian Guide to Healthy Eating* and producing a guide to help students make healthy choices when buying food from the school canteen (FN)

Including ATSI perspectives: This task may be challenging for some students in the class simply because the traditional numeracy competencies that are part of their lives and communities are not precise. They are more holistic so the percentages, partitioning and tiny amounts of ingredients that students are required to work with calls for quite a considerable degree of code switching, which not only takes time and cognitive agility, but can be made more difficult if there are no traditional words, concepts or images that correspond to the

Strategies to include learners with oral backgrounds: These students may have similar challenges to the other groups who have traditional oral backgrounds and differing numeracy traditions. It may be useful to support these students with narrative or interactive learning contexts so the students are able to develop the concepts and are competently able to express the implications of the information on the label. Some students may have been in situations where anything to eat was appreciated, irrespective of its nutritional value.

Authentic Assessment strategies:

Can the students interpret the messages in the jingles?

Do they allow these message to influence their healthy choices?

Can the students successfully describe the pathway to and the map referencing positions of their piece of work on the quilt?

Variations for students from diverse social contexts: There are groups of students who have no opportunities to develop healthier eating habits and so it is increasingly important that they are able to understand the nutritional information on the foods and drinks that they consume. For other students, it may be the diet versions of everything that attracts them so it is useful to highlight that low fat may mean high sugars or artificial sweeteners, which are not always healthy either. It is useful to make it very clear to all students that trans fats are their enemies when it comes to healthy eating so the need to looked for carefully as they may be listed a very tiny print on the labels.

be combined to make an ingredients poster for display. Discuss: Why would some people object to some of the ingredients in toothpaste? Which ingredients might these be and from your research why might some people not want them in their toothpaste? **Task**: in groups or as a class, make the toothpaste or tooth powder recipes.

- After making, try the tooth cleaner with the free toothbrushes
- Select preferred tooth cleaner
- Give reasons using the following criteria on a score of 0–5:
  - Ease of use
  - Cost (work this out from the prices on the ingredients containers or from the till receipt when they were bought)
  - Taste
  - Effectiveness (how clean do the teeth and mouth feel after use)
  - Aftertaste (the lingering taste after cleaning and rinsing).
- Make a tally of the preferences of the other students in the class using the criteria and the scoring rates
- Develop a 'profile' of each of the tooth cleaners. **Use Excel to create any graphic display. For example, a table, a graph, a chart or whichever format students think displays the responses most clearly
- ***Discuss different representations and their similarities and differences.

Healthy Choices: Healthy Eating Years 7/8

Resources https://www.youtube.com/watch?v=xWTEFFlMd4M https://www.youtube.com/watch?v=pOEfKcQs3aAhttps://www.youtube.com/watch?v=vx0ZTy2SWfkhttps://www.youtube.com/watch?v=vx0ZTy2SWfk (this is excellent but you need to subscribe)food labels on cans, packets or jars of drinks and popular foods that show the nutritional information. iPads or computers for research, materials for recording results, popular prepacked items or similar from the school canteen (chips, coke, lollies, hot foods) https://www.youtube.com/watch?v=wO7E-oDeLk0, not so student friendly https://www.youtube.com/watch?v=MrdCBqFYDyo, very student friendly (whole foods and food products).

Task: Watch the YouTube(s) of choice.

Discuss: Why adolescents need to be well nourished. Discuss the food types seen on the YouTube videos watched. These should all contain information about essential food groups and the types of ingredients to limit or avoid. Note that some of the videos refer to whole foods which do not need a nutrition label and food products, which do need labelling. If the canteen sells unwrapped pies, pizza, sausage rolls or other unwrapped foods, then the students may need to be aware that these items were originally packaged and would have had a nutrition label on the bulk packaging.

Task: Students write a report about the food item that they have been given to analyse from the nutrition report indicating the *fraction of any one ingredient in relation to (i) the whole and (ii) any other selected ingredient. The information may also include the following:

- Information about the number of serves in a package
- If the sugar is listed in the top three ingredients
- Information they have researched on the ingredients that they do not recognise and if they are food or not
- Information about the different types of fats
- Information about sugar, salt (sodium) and calcium if applicable
- If the item is stocked in the school canteen or not
- A recommendation regarding the item's withdrawal from the canteen stock or not (giving reasons
- A healthy food rating on a 1–10 scale giving reasons
- In groups, students can attempt to design the healthiest combination of snack (one food and one drink) from the items selected for analysis.
- The combinations can be analysed in the categories used for the single items and the reports indicate the total fats, sugars, salt, etc., of the combination
- All combinations can be compared and discussed in terms of which is the healthiest snack duo. Some new combinations may be created.

Discuss: The implications of eating and drinking any of the combinations on a daily basis. Questions may include the following:

- Is it better to have more fat than salt? Give reasons?
- What are the health implications of consuming too much salt? Too much saturated fat? Trans fats? Which of the combinations have least preservatives?
- Which combinations have the most nutritional value? What is the nutritional value from?
- Does the canteen stock both the selected items? Why would they or why would they not?

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History and the Importance of Numeracy

Heather Sharp

Introduction

As history has only recently become a distinct and compulsory subject from primary school through to Year 10, it is increasingly clear that teachers will need to develop history pedagogical skills and knowledge of historical thinking so that they can effectively teach students. For teachers of primary school students, the need for cross-curricular or multidisciplinary approaches to teaching the quantity of outcomes across multiple syllabuses and curriculum documents continues to be a serious consideration in planning. This chapter sets out to address this by linking the Australian Curriculum to pedagogical approaches teachers can use to identify the numeracy embedded within the subject of history.

Without an accurate understanding of the skills and knowledge of the concepts unique to the discipline of history, teachers are at risk of teaching students a narrative that is void of historical thinking and inquiry, and of potentially reducing history to only a story for students to know about. However interesting teachers might make these stories (and indeed narratives can be a powerful and useful way to engage students in the study of history), if students are not learning the historical thinking concepts that are so important to the discipline, they will not be able to apply what they have learnt to other contexts and in varying situations. The connections between two important areas of learning—history and numeracy—are explored, with examples provided of how numeracy is authentically embedded into the teaching of history to primary school-aged students.

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Numeracy and History

In an increasingly crowded school curriculum, there are pragmatic reasons for integrating KLAs, but there are also important pedagogical reasons for doing so, including those related to interdisciplinary concepts and knowledge, motivation and engagement. There is recognition by curriculum authorities that numeracy is an important skill to embed in the history curriculum. For example, in the Australian Curriculum, this is demonstrated most clearly via two statements. The first, ‘General Capabilities’, discusses numeracy in general and then provides brief ideas using two numeracy competencies, scale and time that can be embedded within history teaching:

> Students become numerate as they develop the knowledge and skills to use mathematics confidently across all learning areas at school and in their lives more broadly. Numeracy involves students in recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully.
>
> Students develop numeracy capability as they learn to organise and interpret historical events and developments. Students learn to analyse numerical data to make meaning of the past, for example to understand cause and effect, and continuity and change. Students learn to use scaled timelines, including those involving negative and positive numbers, as well as calendars and dates to recall information on topics of historical significance and to illustrate the passing of time. (Australian Curriculum and Reporting Authority [ACARA], 2015a: “Numeracy”.)

Mathematics is also explicitly linked to history teaching, in the section, *Links to the other learning areas.* Here, quantitative reasoning is emphasised as the link between the two curriculum areas:

> Much of the evidence and reasoning in historical understanding is quantitative: chronology, demography, economic activity, changes in the movement of peoples and in the size and reach of institutions. All of these call for an appreciation of numerical scale and proportion. (ACARA, 2015b: n.p.)

Defining History

Continuing the school learning context in discussing a definition of *history*, the multiple meanings this term has is broached by Hoepper—who connects this term to classroom teaching—by writing:

> In popular discourse, ‘history’ is synonymous with ‘the past’. Generally, when someone refers to ‘the history of Australia’ or ‘Australia’s history’ they really mean ‘what happened in the past’. So, in classrooms, it’s probably valuable to discourage that usage and to encourage students to use the term ‘the past’ instead, keeping the term ‘history’ for other uses.

> 'History' is better used to mean a constructed, interpretive, explanatory depiction of the past. Usually it's capitalized as 'History'. Used this way, 'the History of Australia' means 'what an historian has constructed as a rigorous, defensible version of elements of Australia's past'.
>
> …the term 'History' (or 'history'!) is also used to describe what historians do—the process of producing histories. So 'History' can mean 'the past', the 'constructed descriptions and explanations of the past' and 'what historians do to investigate the past'. (2007: 33)

In order to fully understand these definitions and the implications for teaching and learning, individuals need to have sophisticated understandings of time, sequence and reasoning.

Using Primary Sources

Primary sources are artefacts that remain from the past, and any piece of information used for constructing history. Primary sources are created during the specific time period under investigation, or at a later date by someone involved in the events under investigation. Examples include the following: unpublished documents such as letters, pottery, photographs, Hansard, newspaper articles, quilts, speeches, maps and political cartoons. Therefore, when teaching history through the use of primary sources, a process of selection has to be made of what to include and what to exclude for teaching and learning.

Using Secondary Sources

Put simply, a secondary source interprets and analyses primary sources (and often in the case of curriculum materials such as textbooks, this is done in such a way that the original source is hidden or not properly attributed). Examples of secondary sources include textbooks, newspaper articles, or a book about the causes of the Cold War. In discussing the use of sources, Hoepper states:

> Students should learn about the categorization of sources into 'primary' and 'secondary' and discuss the relative merits of each…Hopefully they'll also be comfortable if the distinction between 'primary' and 'secondary' becomes blurred for example, a 2007 history textbook about Ned Kelly may be a secondary source about Kelly but a primary source of evidence about printing techniques in 2007. (2007: 35)

Even these foundational historical notions are based on the understanding of ordinal number.

Pedagogical Approaches to Teaching and Learning History in Classrooms

The predominant ways that history is recommended for teaching in schools is through an inquiry approach. This pedagogical process adheres to progressivist and constructivist teaching and learning principles. The focus on the *individual* as the starting point for structuring curriculum forms the central ideas of the progressivist approach, which '…sees knowledge as constructed through individual experience and driven by individual need and interest…curriculum…is determined by contemporary issues which become the occasion for exploring personal feelings and values' (Gilbert, 2003: 7). This definition provides a clear explanation of how the *inquiry approach* is incorporated within a progressivist approach to teaching.

The epistemological underpinnings of the inquiry approach encompass constructivist beliefs of how knowledge is attained, particularly that students learn best 'by doing'. Bruner, and Dewey before him, are both commonly credited with developing this approach for schooling contexts.

In a practical (classroom context) sense, inquiry processes incorporate or involve:

> …commitment of the learner to continuous reflection and re-evaluation of the direction and purposes of the inquiry…[and]…Productive inquiry cannot be conducted in a strictly linear fashion with the questions that guide the inquiry remaining the same throughout. Students and teachers need to adopt flexible approaches so that in the light of information gathered, knowledge being constructed, and skills and processes being enhanced, additional or different questions and/or hypotheses can be adopted. (Naylor, 2000: 8)

Referencing the epistemological emphasis of progressivist curriculum, an inquiry process of learning and a type of *New History* (and at the same time espousing the importance of teaching history using primary sources), Hoepper and Quanchi write:

> …these new approaches encourage young people to see that histories are interpretations of the past, and that they are constructed using the available sources of evidence. Thus, histories are partial in two senses—they are incomplete (because no-one can have all the evidence, and tell the whole story) and they reflect the backgrounds and beliefs of the people who produce them (because it's impossible to tell the objective story of the past). Students are therefore encouraged to read histories more critically—to discern perspectives, standpoints and biases. (2000: 5)

Connected with the inquiry approach, and continuing to follow constructivist notions of teaching and learning, there are several complementary pedagogical approaches that teachers can be informed by when teaching History that have all gained traction in recent times. Two of these are briefly outlined below, including *The Six Historical Thinking Concepts* and *Developing Historical Empathy*.

Six Historical Thinking Concepts

The six historical thinking concepts, made well known by Seixas and Morton in their text *The Big Six Historical Thinking Concepts* (2013) aim to develop students' historical literacy skills by explicitly articulating the concepts that make up the work of an historian and how this can inform the teaching and learning of history in schools. The concepts are:

- Establish historical significance;
- Use primary source evidence;
- Identify continuity and change;
- Analyse cause and consequence;
- Take historical perspectives; and
- Understand the ethical dimension of historical interpretations.

These historical thinking concepts have become accepted as a legitimate and recognised way to teach the skills of an historian to students. They provide practical strategies for how teachers can structure their planning of teaching and learning activities across a unit of work. For an in-depth examination of each, including teaching exemplars, consult *The Big Six Historical Thinking Concepts* (Seixas & Morton, 2013) or the website of *The historical thinking project* (2012). Importantly, they develop in students the ability to think critically in the context of an historian's work. They also require students to have sound understandings of mathematical concepts such as duration, elapsed time, rate of change, past present and future, identifying pattern and relationships and reasoning.

Historical Empathy

Historical empathy is increasingly been seen as an important skill to foster in students' understanding of history, particularly as a way to avoid 'presentism' (where current ideas and perspectives are imposed on past events, people and topics) and necessitates students to have the skills of adaptive reasoning. Yilmaz defines this term in the following way:

> …empathy or historical imagination as the ability to see and judge the past in its own terms by trying to understand the mentality, frames of reference, beliefs, values, intentions, and actions of historical agents using a variety of historical evidence. Empathy is the skill to re-enact the thought of a historical agent in one's mind or the ability to view the world as it was seen by the people in the past without imposing today's values on the past. (2007: 331)

The term *empathy* can be met with confusion particularly by those who conflate *sympathy* with *empathy*. However, scholars of historical empathy are consistent in their pointing out that empathy does not mean sympathy. Another approach to viewing the term *empathy*, is looking at historical perspective, often called *perspective taking* (see, for example, Barton, 1996).

Conclusion

It is worth noting that the perspective taken throughout this chapter is not that numeracy is an add-on when teaching history—as something onerous or extra to fit into an already crowded curriculum—but rather that numeracy is integral to the teaching and learning of history, as numerical competencies constitute part of the required knowledge and understanding of this discipline area. Examples of numeracy activities are included in the history curriculum where they enhance the

Differentiation : To accommodate those children who may be unable to name significant events, the time line can be used to name the daily routine Monday- Saturday. For an extension activity, students can then (bar) graph the timeline events (for example, 12 students started school aged five; and 7 started school aged four) on graph paper, in their own books, or using smart technology.

Australian Curriculum Mathematics Outcome

(ACMMG007)

Numeracy Links

* Compare and order duration of events using everyday language of time sequencing familiar events in time order

Australian Curriculum Subject outcomes and Elaborations

Personal and family histories

Who the people in their family are, where they were and raised and how they relate to each other (ACHHK001)

Elaboration: How the stories of families and the past can be communicated, for example through photographs, artefacts, books, oral histories, digital media, and museums.

The Learning task- History - Foundation

: Constructing a personal history timeline.

In this lesson, students construct a personal timeline titled *Stages of my Life* and plot key events learning the numeracy concept of calibration of spaces.

ATSI considerations For students who need, or like, to learn Maths kinaesthetically, this activity could be done using an abacus to demonstrate the equal spacing between events on a timeline. Family and community are traditionally very important for these students. There may be protocols around some of the information students ask about and issues of respect around the deceased if mention in a child's event - AboriginalTorresStraitCulturalProtocols-1207.pdf http://www.terrijanke.com.au/img/publications/pdf/

Strategies to support learners with oral backgrounds: Many students with backgrounds of oracy are from African or ATSI backgrounds. It may be wise to consider the impact of the personal history task on students with refugee experiences. This may revive the trauma experienced by themselves or their families, even if they students are too young to recall specific events. There may easily be a total loss of any record of the students' birthdates, pictures from earlier childhood and a lack of support from the family to discuss events in their children's lives with them. They may also have no one with whom to discuss their childhood or, conversely it may be rich in narrative and story.

Authentic Assessment strategies

Assess each child's contribution and work product in terms of meeting all the outcomes and elaborations.

Variations for students from diverse social contexts:

Some students may not have any knowledge of their earlier childhoods though separation, foster care, family dissolution or other trauma or neglect. There may be similar conditions to those experienced by students of oracy background. Or equally it may make a significant contribution to the students' knowledge of their early lives. It may be wise to check the complexities of the personal histories prior to planning the task.

teaching of history, rather than being included for 'numeracy's sake'. Understanding the way timelines are structured, reading and interpreting graphs, and spatial awareness of large structures such as pyramids, for example are important skills in history. Of course, for teachers this does not mean that numeracy is taught as part of a history lesson 'just for the sake of it', or due to a feeling of compulsion to embed this core learning area into a lesson, but rather to treat numeracy authentically by teaching skills students require to learn to deepen their understanding of both history and mathematics.

The learning activities in this chapter demonstrate ways in which history and numeracy can complement each other via engaging learning activities for school students.

Early Stage 1: History—Personal and Family Histories: A Personal History Timeline

Suggested Implementation: Interactive whiteboard, large sheets of paper, graph paper with large squares, pencils/crayons, simple timeline on paper/cardboard, landscape orientation divided into 5–6 equal sections, entitled 'Birth to school' (*or complete on the interactive whiteboard)* showing one key sample event for each year.

Implementation Strategies:

(i) Explain the calibration of spaces (equal size, no gaps and no overlaps) and the plotting of events on a timeline.
(ii) Ask students to suggest important events from their own experiences.
(iii) Suggest where the event should be plotted.
(iv) Students to work individually to create their own personal timeline using the example discussed.
(v) *Students fill out a timeline (A4 paper suggested, landscape orientation) with the title of: 'Stages of my life by <name>' at the top; and at the bottom of the page, have a timeline drawn, with the stages already defined, copying the one the students worked on as a whole class group.
(vi) Students can write or draw in the column their experiences. For example, moving house could be represented by a drawing of a house; a new brother or sister could have a drawing of a baby or the child's name written. Students can then discuss in small peer groups stories of their families (which assists to meet the history outcome.
(vii) Bring students back together to discuss common experiences and individual ones.

Differentiation :

The celebration of special days can also lead to the problematisation of knowledge. For example, Christmas can be viewed as both a religious day and a cultural event. It is not only Christians who celebrate Christmas, so the differences and similarities of observing this day can be discussed between Christians, people who do not have a faith, and those from other religions who celebrate Christmas as a cultural event (for example, many Muslim people in Australia celebrate Christ mas even though they consider Jesus Christ to be a prophet).

Australian Curriculum Mathematics Outcome

(ACMSP263). -

Numeracy Links

* Represent data with objects and drawings where one object or drawing represents one data value.

** Describe the displays - describing displays by identifying categories with the greatest or least number of objects

Australian Curriculum Subject outcomes and Elaborations

Present and past family life: Observing special days

How the present, past and future are signified by terms indicating time such as 'a long time ago', 'then and now', 'now and then', 'old and new', 'tomorrow', as well as by dates and changes that may have personal significance, such as birthdays, celebrations and seasons (ACHHK029)

The Learning task Year 1: Observing special days.

Students identify special days/events that they and their family celebrate/observe; responses are then collated as a class group with the numeracy skill of graphing used to create a bar graph demonstrating the frequency of classmates who celebrate/observe specific special days/events.

ATSI considerations: This is an ideal opportunity to ask students about events in their aboriginal history that are still celebrated as Dreamtime stories, legends and stories. There are also a number of festival or celebratory days throughout the year. http://www.cairns.qld.gov.au/__data/assets/pdf_file/0003/67647/SigDates.pdf http://www.australia.com/en/events/aboriginal-events.html

Strategies to support learners with oral backgrounds: These students may celebrate days that are unfamiliar to you as the teacher. Also many are Christian or Muslim. It is wise to investigate the details of students' backgrounds by chatting to parents or caregivers so that you can be informed. Many students may not know their birthdays.

Authentic Assessment strategies

Assess each child's contribution and work product in terms of meeting all the outcomes and elaborations.

Variations for students from diverse social contexts: There are a number of groups of people in Australia who do not celebrate Christmas, birthdays etc. there are also students who do not know their birthdays for a number of reasons, including issues of poverty. The same situation may also be the case at Christmas. This topic requires a great deal of sensitivity. For some students Monday is the special day because they come to school and are fed, looked after and feel safe after the weekend.

(viii) Create class timeline using the students' information and slips of paper for gluing onto class timeline.

Question prompts and example lines of inquiry:

These prompts can be used both in the whole class grouping at the beginning of the lesson, and also when the teacher visits individuals and small peer groups as they are working:

Do you have a younger brother or sister? How old were you when they were born?

Have you ever moved house? How old were you?

What about starting school? Is that an important event or milestone in your life? How old were you when you started school? (This provides a good opportunity to show that the students' timelines will be different as they will have started school at different ages.)

Bringing it all together:

Display the collated timeline and the students' personal timelines around the classroom. Encourage students, where appropriate, to ask their parents about their own family's important events so that they can understand the rich variety of experiences that make up a timeline.

Year 1: History—Present and Past Family Life: Observing Special Days

Suggested Implementation: Student activity sheet

Pre-activity: Prior to the lesson, ask students to discuss with their family (for example parents, siblings, grandparents, other extended family) special days they observe/celebrate. To assist this process, consider providing students with a template worksheet to fill in as they discuss this with their parents. Completing this pre-activity will enable the class-based activity to be completed more accurately. A sample recording sheet is included at the end of this chapter as an example of what could be provided to students.

Implementation Strategies:

(i) *Class-based activity:* As a class group, identify special days that the children celebrate/observe in their family (this can be family-specific traditions, cultural and/or religious special days).

(ii) *Collate the information on a smart/white board under headings such as: birthdays (whose birthdays are celebrated), anniversaries (for example, wedding), religious days (such as Christmas, Easter, Ramadan Hanukah, confirmation, bar mitzvah), cultural days, national days (such as Australia

Differentiation :

When discussing the various seasons, go to the "Things to Think About" tab on the ABC Splash video webpage, which contains a variety of prompt questions to engage students in the inquiry process: http://splash.abc.net.au/home#!/media/1566152/

Australian Curriculum Mathematics Outcomes
(ACMMG040)

(ACMMG041)

Numeracy Links

*Name and order months and seasons, *investigating the seasons used by Aboriginal people, comparing them to those used in Western society and recognising the connection to weather patterns. (See ATSI consideration)*

Use a calendar to identify the date and determine the number of days in each month

Australian Curriculum Subject outcomes and Elaborations

How the present, past and future are signified by terms indicating time such as 'a long time ago', 'then and now', 'now and then', 'old and new', 'tomorrow', as well as by dates and changes that may have personal significance, such as birthdays, celebrations and seasons (ACHHK029)
Elaborations:

- examining Aboriginal and Torres Strait Islander seasonal calendars (for example the Gagadju (Kakadu) and the D'harawal (Sydney) calendars, each with six seasons, the Arremte (central Australia) with five, the Woiwurrung (Upper Yarra Valley) with seven, and north-east Tasmania with three

Sequence familiar objects and events (ACHHS031)
Elaborations:

- using visual sequences of time such as a 'days of the week' chart, a class timetable or a calendar and marking significant dates on them.

Learning task**: Year 2 -Present and past family life: Sequencing days, months and seasons.**

Students draw on their background knowledge of the seasons, months of the year, and days of the week to understanding the numeracy concept of sequencing by putting in order months and days, and by learning about sequencing terms such as yesterday, today, tomorrow.

ATSI considerations: When considering Aboriginal and Torres Strait Islander perspectives, consider consulting with the local community regarding their knowledge of the seasons and how they fit. If appropriate, invite an elder or spokesperson from the local community into the classroom to discuss with students local seasons and signs of new seasons (flora, fauna for example). The indigenous notion of time is also very different to that of the western concept. These students also have traditional ways of explaining and understanding seasons.

Strategies to support learners with oral backgrounds: Many students in this group are amongst those students with refugee experiences. Present family may be considerably deleted as a result of conflict and the subsequent trauma. The discussion of past lives or experiences (even if second hand from parents or others) may be distressing or unable to be retrieved. Their seasons may be expressed differently.

Authentic Assessment strategies

Assess each child's contribution and work product in terms of meeting all the outcomes and elaborations.

Variations for students from diverse social contexts: Again there are many reasons why discussions of family, extended families etc. may be problematic for students. Consideration needs to be made for students with blended families, deceased parents, and same gender parents, foster parents etc. so that students are not inadvertently introduced to a stereotypical idea of what comprises family. For some students family is the entire 'mob'.

Day, Anzac Day), family days, award and end of year ceremonies (piano recital and sports awards ceremony, for example).

(iii) **In addition to learning about and discussing the cultural difference and similarities in the celebration/observation of the identified special days (the students can explain the importance of the special days to them and their families), the information from the class can be graphed into column graphs, showing the frequency of students who celebrate specific special days.

(iv) Synthesise the activity by plotting these days on a calendar (either physical, month by month yearly calendar; or an e-calendar from an online source or created using a Smart Board).

(v) Display in a prominent place in the classroom and/or email to all parents/caregivers. This activity can show the diversity of the student population within one classroom.

Question prompts and example lines of inquiry:

To engage the students with thinking about what a special day or event is (and this is especially useful when providing students with an activity sheet) ask them what are special times that their family come together to celebrate. Prompt questions such as: What do you do? Do you wear special clothes? Do you eat special food?

Bringing it all together:

Using their recording sheets and information discussed in class, students are to write an extended narrative with an accompanying illustration that retells the celebration or observation of a selected special day. Display students' narratives around the classroom.

Year 2: Present and Past Family Life: Sequencing Days, Months and Seasons

Suggested Implementation: Internet facilities and a screen to show audio-visual material, whiteboard, writing materials, paper plates (2 per student), brad pin/split pin (1 for each students), colour pencils/crayons, calendar months worksheet, flash cards (optional).

Implementation Strategies:

Depending on the cohort, this series of activities could take place over one or several lessons. The three parts should be completed in order, but can be spread out across the day or the week.

Activity a: Learning about the Seasons: whole class

Differentiation

Teachers can extend this activity by using the fifth row of the abacus for making predictions about the future. In the Australian Curriculum for History, this forms part of the Year 1 Knowledge and Understanding Outcome: "How the present, past and future are signified by terms indicating time such as 'a long time ago', 'then and now', 'now and then', 'old and new', 'tomorrow', as well as by dates and changes that may have personal significance, such as birthdays, celebrations and seasons (ACHHK029). Invite students to think about future events that they predict will happen, for example starting the next year at school, high school, post-high school. This can also be an interesting way to engage students in this activity and extend their learning.

Australian Curriculum Mathematics Outcome
(ACMSP069)

Numeracy Links

*Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies

**exploring meaningful and increasingly efficient ways to record data, and representing and reporting the results of investigations

Australian Curriculum Subject outcomes and Elaborations

Sequence familiar objects and events (ACHHS031)

Elaboration: using visual sequences of time such as a 'days of the week' chart, a class timetable or a calendar and marking significant dates on them creating a timeline, slideshow or story using photos

How the present, past and future are signified by terms indicating time such as 'a long time ago', 'then and now', 'now and then', 'old and new', 'tomorrow', as well as by dates and changes that may have personal significance, such as birthdays, celebrations and seasons (ACHHK029)

Elaboration:
discussing, for example, what happened yesterday, what is likely to happen tomorrow, upcoming birthdays, celebrations and seasons, and ordering these references to time in sequence using terms such as 'before', 'after', 'next' and 'then'

The Learning task History- Year Three

Year 3: Using an abacus to construct a personal time line. Using an abacus, students construct a personal timeline with multiple dimensions, including: family events, personal events, and education events. Numeracy skills of spacing, sequencing, chronology, and counting are applied in this activity .*For noting:* This activity is aimed at year 3 students, however could be adjusted to suit year 5 students studying the topic *The Australian colonies*, investigating the key question: How did an Australian colony develop over time and why? It could also be used to teach year 7 students studying the topic *The ancient world*. The teacher will need to adjust the activity to suit the age of the learner. **Activity origin:** Adapted from activities originally sourced from :http://splash.abc.net.au/home#!/media/1566152/ http://adventuresofarainbowmamamama.blogspot.com.au/2011/07/7-days-of-week.htmlhttps://www.pinterest.com/pin/38280665556889016/

ATSI considerations

There may be protocols around some of the information students ask about and issues of respect around the deceased if mentioned in a child's personal time line.http://www.terrijanke.com.au/img/publications/pdf/14.OxfamAus-AboriginalTorresStraitCulturalProtocols-1207.pdf

Strategies to support learners with oral backgrounds Many students with backgrounds of oracy are from African or ATSI backgrounds. It may be wise to consider the impact of the personal history task on students with refugee experiences. This may revive the trauma experienced by themselves or their families, even if they students are too young to recall specific events. There may easily be a total loss of any record of the students' birthdates, pictures from earlier childhood and a lack of support from the family to discuss events in their children's lives with them. They may also have no one with whom to discuss their childhood or, conversely it may be rich in narrative and story

Authentic Assessment strategies Students demonstrate that they have met the outcomes, by being able to discuss with teachers and peers what the various terms mean in relation to each other. For example the teacher may ask: "If today is Monday, what day was it *yesterday*?" Display student work around the classroom or in portfolio folders that students have access to as a reminder of the outcomes learnt.

Variations for students from diverse social contexts Some students may not have any knowledge of their earlier childhoods though separation, foster care, family dissolution or other trauma or neglect. There may be similar conditions to those experienced by students of oracy background. Or equally it may make a significant contribution to the students' knowledge of their early lives. It may be wise to check the complexities of the personal histories prior to planning the task.

(i) *Prior to showing students the ABC Splash video titled ‘What’s in a year?’ ask students what they know about seasons already, for example how many are there, how long do they go for, what season are we in now.
(ii) Group student responses on the white/interactive board. At this stage, do not tell them about other ways to view seasons, unless the students raise this topic.
(iii) Show the video to the students (3 min and 9 s) which incorporates various views of seasons: the northern hemisphere/European view of four seasons whereas northern Australia has six seasons.
(iv) At the conclusion of the video, go back to the white/interactive board where student responses are grouped and have them consider what new information they can add and what may need to be taken away with the new knowledge they have gained.

Activity b: Months of the year

(i) *The information from the video can then be used as an orientation to learning about months of the year. Go through the months of the year (there are many innovative ways to approach this, including rhymes that most, if not all, teachers are familiar with).
(ii) **Provide students with a *Months of the Year* activity sheet that requires them to include the previous month, this month, next month. This teaches students the concepts of before/previous, now and next. For a worksheet activity that demonstrates this, access: https://www.pinterest.com/pin/38280665556889016/ or http://www.worksheetfun.com/?s=months&submit.x=0&submit.y=0.

As an alternative activity or an extension: list the months of the year on individual flash cards for students to sequence and play games with each other.

Activity c: Days of the week wheel

(i) At this stage of their schooling, it would be expected that students know the seven days of the week; however they may still be learning about *yesterday, today* and *tomorrow*. This part of the activity assists students to understand this concept of time. Introduce the activity by going over the days of the week.
(ii) Then, have students settled at their desks, preparing to do an arts activity that will assist them to remember the days of the week while at the same time learning about *yesterday, today* and *tomorrow* in a way that accommodates kinaesthetic and visual preference learners. The art activity below is adapted from: http://adventuresofarainbowmamamama.blogspot.com.au/2011/07/7-days-of-week.html
(iii) Take two paper plates and trim one down to make the smaller circle.
(iv) Divide the plates into 7 equal parts—a little more than 51 degrees if you happen to have measuring apparatus on hand.

(v) Write the names of the days in sequence around the plate.
(vi) The smaller plate introduces a second concept: yesterday, today, tomorrow. Attach the two plates at the centre with a brad (split pin) so that the top plate spins.
(vii) The student lines the 'today' segment up with the current day of the week and can also see what 'yesterday' was and 'tomorrow' will be…The student can 'see' the cyclical nature of the week; the particular sequence of days; the names of the days and how they are spelt for future reference.

Year 3: History—Using an Abacus to Construct a Personal Time Line

Suggested Implementation: Whole class grouping for teacher demonstration; small group work and/or individual work.
Abacus, tags/labels with various events written and/or drawn (for example, losing first tooth, starting school, born, baby brother born, first ride on a bike without training wheels), graph paper, paper and writing materials.

Implementation Strategies:

(i) *Students to have an abacus (either one for each student, or one per small group of 3–4).
(ii) Students also to have tags with a variety of events written on one side of the tag (for example, started school) and on the reverse side, the same event drawn (for example, a logo of the school so that students understand that this signifies starting school).
(iii) *The teacher explains that each row of the abacus represents a context. This activity will work best if the teacher demonstrates. With the class assisting, how to construct a timeline before students embark on this activity either individually or in small groups. The following are suggestions for each row of beads on the abacus:

- Top row: years (2005–2014)
- Second row: family (born, new sister, mum got a new job, family got a pet dog)
- Third row: personal (learnt to ride a bike, lost first tooth, went to a museum)
- Fourth row: education (daycare, preschool, learnt to write name, school)

(i) While some tags (written and drawn) should be provided for students, it is also a good idea for students to contribute their own events that are significant to them for each of the topics)

(ii) **While the teacher is demonstrating with the students that the tags are tied to individual beads, the teacher should be engaging in enabling questions that allow the students to learn about:

- Spacing (each bead on the topic row, representing years, should be spaced equally apart)
- Sequencing (commencing daycare occurs before commencing preschool or school)
- Chronology (that an event that happened in 2006 will be placed on the abacus before an event that happened in 2010)
- Counting (the years can be counted, events on each row can be counted)

Question prompts and example lines of inquiry:

For the second, third and fourth rows, the teacher can ask questions such as: 'Do you have a younger brother/sister?' If so, 'How old were you when they were born?'; 'have you lost a tooth yet? How old were you when you lost it?'; 'Do you remember a holiday you went on, maybe with your family?'; 'Did you got to preschool?'

**Extending on from these types of questions, the teacher could, with small groups of students ask the students why there are similarities and differences in the students' responses; have students identify the similarities and differences. Encourage students to think about what might happen in the future and to make predictions based on their current and past experiences.

Bringing it all together:

To deepen students' understanding and appreciation of the personal timeline created, students could add sources of evidence to support what they have included in their abacus-timeline. For example, photographs, an audio or audio-video recording, tickets to a museum, their 'lost tooth' pillow. For ideas on extending this task, consult *Making History* (Taylor & Young, 2003, p. 41). If displaying of abacuses around the classroom is (understandably) not feasible, then taking photographs is a great alternative, and students can email a copy to their parents/caregivers as a way to display their work to their families.

Differentiation Rail Transport

Table 6.5 Rail transport: Lines open to traffic, and passengers and goods carried, Queensland, 1895–96 to 1995–96

Year	Lines open to traffic (a)	Number of passenger journeys (b)	Passenger journeys per capita (c)	Goods and livestock carried
	km	'000	number	'000 tonnes
1895–96	3,862	2,274	5.1	1,167
1900–01	4,508	4,761	9.6	1,739
1905–06	5,049	4,569	8.6	1,951
1910–11	6,225	8,299	13.9	3,348
1915–16	7,994	13,939	20.3	4,076
1920–21	9,257	14,908	19.9	3,930
1925–26	10,042	28,384	33.6	5,188
1930–31	10,507	22,009	24.0	3,920
1935–36	10,569	25,244	26.0	4,739
1940–41	10,569	26,194	25.4	5,690
1945–46	10,569	38,200	35.2	5,850
1950–51	10,557	34,118	28.3	7,297
1955–56	10,390	35,647	26.2	8,311
1960–61	10,177	28,876	19.2	8,109
1965–66	9,310	25,979	15.7	10,211
1970–71	9,329	29,536	16.3	15,665
1975–76	9,844	34,278	16.5	33,118
1980–81	9,932	31,873	13.8	41,504
1985–86	10,225	41,504	16.0	73,599
1990–91	10,015	42,990	14.7	82,965
1995–96	9,300	40,082	12.1	96,200

(a) At 30 June.
(b) For 1920–21 and earlier years, excludes season ticket holders.
(c) Calculated using population at 31 December.
Source: ABS, *Queensland Year Book 1996*; Queensland Rail, *Annual Report 1995–96*.

Source: Office of Economical and Statistical Research. (2009). *Queensland Past and Present: 100 Years of Statistics, 1896–1996.* Queensland Government, p. 186. Available online at: http://www.oesr.qld.gov.au/q150

Australian Curriculum Mathematics Outcomes

(ACMSP096)

Numeracy Links

* Construct suitable data displays, with and without the use of digital technologies, from given or collected data.

**Include tables, column graphs and picture graphs where one picture can represent many data values

Australian Curriculum Subject outcomes and Elaborations

Historical Knowledge and Understanding:
ONE important example of change and ONE important example of continuity over time in the local community, region or state/territory; for example, in relation to the areas of transport, work, education, natural and built environments, entertainment, daily life (ACHHK061)

Elaborations: investigating a development in the local community from the time of European settlement to the present day (for example through photographs, newspapers, oral histories, diaries and letters)

The Learning task **Year 4: Identifying continuity and change: Creating a graph from statistical data.** Students take statistical information from primary sources to create a variety of graphs (bar, line, pie as examples). Students then use the statistical information to write an extended narrative that demonstrate their understanding of what the graphs communicate and their numerical values.
Road Transport Statistics Source: Office of Economical and Statistical Research. (2009). *Queensland Past and Present: 100 Years of Statistics, 1896–1996.* Queensland Government, p. 179. Available online at: http://www.oesr.qld.gov.au/q150

ATSI considerations: Western mathematics and Aboriginal mathematics are both culturally situated and dealing with large numbers as statistics may be problematic for these students. It is recommended that the students use concrete materials, environmental contexts and issue related to the land to help them engage more fully. It is also possible that using the concrete materials to construct and deconstruct the statistics themselves may contribute to the development of the conceptual understanding and symbolic representation.

Strategies to support learners with oral backgrounds: Many of these students have had interrupted schooling and may have difficulty keeping their factual, strategic and conceptual development in congruence with their chronological age, even though in other circumstances they would cope effectively. Data sets that contain smaller numbers as the statistical data and subject matter for investigation that is within their own experience may support their development in the context of their unfamiliarity with written mathematical representations although their understanding of symbolic representation may be more highly developed than their peers.

Authentic Assessment strategies

Assess each child's contribution and work product in terms of meeting all the outcomes and elaborations.

Variations for students from diverse social contexts

Students often rely on the information from their own experiences in their cultural and social contexts as the reference from which to make meaning of new learning. Students need to be allowed to suggest the area/topic around which they are to collect and interpret the data. The numeracy context is one in which student social and cultural contexts impact considerably.

Year 4: History—Identifying Continuity and Change: Creating a Graph from Statistical Data

Suggested Implementation: Statistics (provided by the teacher), graph paper (hard copy or online, or a combination of the two), writing materials, computer.

Implementation Strategies:

(i) Almost any topic of history that deals with data is relevant for this activity, and in consideration of the topic covered for this outcome (for example, history of road transport, rail, or work), provide students working in small groups of 3–5 with statistics (primary sources) that they can use to input the data to graph paper, an excel document, or an online graph creator (links listed below). *The statistical information can be used to create a variety of graphs (bar, line, picture graphs as examples). Example statistics are included in this section (for rail transport and for road transport) that can be used to create graphs.

(ii) Inform students that they are to identify continuity and change by creating a graph from data provided. To generate graphs: Automatically generate as well as manually generate so that students develop the required mathematical background skills for this, and other, tasks.

(iii) **Use the graph to construct an historical narrative on the topic, including a critique of the numerical data, **using a format where one picture (icon) represents many values.

Question prompts and example lines of inquiry:

When preparing to present their information, whereby students need to communicate their understanding of the topic, ask students to consider why they think there are differences in the statistics between years, locations, types etc.

Bringing it all together:

This activity can form part of a larger lesson, or series of lessons, on the selected topic. Students can then use the graphs they have generated from the provided data/statistics to produce a report or a presentation, meeting the outcomes and elaborations listed in the *Historical Skills* section aligned with the content.

For this immediate lesson, students can demonstrate their understanding by having produced graphs in groups, with each individual member being able to explain what the graphs communicate and their numerical values.

Additional resources:

Teachers can use *TableBuilder* from the Australian Bureau of Statistics (ABS) to make data more accessible for students so that they can then create graphs or use it in some other way to communicate historical knowledge, mathematically. The ABS describes *TableBuilder* as: 'TableBuilder is an online self-help tool which enables users to create tables, graphs and maps of Census data':

Differentiation

Students can demonstrate their understanding of the historical skill involved by writing a short response to the question: “How can quantitative data be used to write history?” and explaining the continuity and change that can be evidenced from their pictorial representations

Australian Curriculum Mathematics Outcomes
(ACMSP119)

Numeracy Links

*Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies

**identifying the best methods of presenting data to illustrate the results of investigations and justifying the choice of representations

Australian Curriculum Subject outcomes and Elaborations **Outcomes:** The reasons people migrated to Australia from Europe and Asia, and the experiences and contributions of a particular migrant group within a colony. (ACHHK096)

Elaborations:

- identifying the reasons why people migrated to Australia in the 1800s (for example as convicts; assisted passengers; indentured labourers; people seeking a better life such as gold miners; and those dislocated by events such as the Industrial Revolution, the Irish Potato Famine and the Highland Clearances)

The Learning task

Year 5: Using databases to create quantitative data to develop narrative writing. Students use a database of statistics from an historical event to create a graph to represent the information. Students critique the information by considering how it can be interpreted from a variety of perspectives and write an extended narrative reporting on the events, using the graph to inform their writing. The extended narrative is a demonstration that students can translate quantitative data into qualitative writing.

ATSI considerations: Western mathematics and Aboriginal mathematics are both culturally situated and dealing with large numbers as statistics may be problematic for these students. It is recommended that the students use concrete materials, environmental contexts and issue related to the land to help them engage more fully. It is also possible that using the concrete materials to construct and deconstruct the statistics themselves may contribute to the development of the conceptual understanding and symbolic representation.

Strategies to support learners with oral backgrounds: Many of these students have had interrupted schooling and may have difficulty keeping their factual, strategic and conceptual development in congruence with their chronological age, even though in other circumstances they would cope effectively. Data sets that contain smaller numbers as the statistical data and subject matter for investigation that is within their own experience may support their development in the context of their unfamiliarity with written mathematical representations although their understanding of symbolic representation may be more highly developed than their peers.

Authentic Assessment strategies

Assess each child’s contribution and work product in terms of meeting all the outcomes and elaborations.

Variations for students from diverse social contexts: Students from oracy backgrounds will be well supported in the development of narrative as will a number of other students whose cultural and social backgrounds are heavily invested in narrative as way of making meaning. It is important to introduce new ideas in simple language initially and check continually for student understanding of the tasks and the teacher directions.

http://www.abs.gov.au/websitedbs/censushome.nsf/home/tablebuilder?opendocument&navpos=240

Teachers can generate their own statistics for the topic relevant to their class at: http://www.abs.gov.au/

Online graph creators (free):

https://nces.ed.gov/nceskids/createagraph/

http://www.onlinecharttool.com/

http://www.mathsisfun.com/data/graphs-index.html

Sample Statistics

Road Transport (Table 1)

Table 1 Road transport: average distance travelled by passenger vehicles by State and Territory, Australia, 1971–1995

12 months to 30 September	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust
					– 000 km –				
1971[a]	16.1	16.4	15.1	16.1	16.4	14.3	16.6	n.a.	15.9
1976	15.6	15.7	14.6	15.0	16.0	13.7	15.5	17.3	15.4
1979	14.8	15.6	14.6	15.0	15.9	12.9	14.5	16.6	15.1
1982	15.4	15.2	15.6	14.9	15.6	14.4	14 8	17.1	15.3
1985	15.4	16.0	15.4	14.2	16.0	14.2	16.5	15.6	15.5
1988	16.1	16.4	15.4	14.4	15.7	13.9	15.3	15.7	15.8
1991	14.2	14.2	15.0	13.5	14.4	12.3	15.4	16.3	14.3
1995	13.7	14.2	16.3	13.4	14.6	13.0	13.8	16.4	14.4

Source ABS, survey of motor vehicle use, 1971–1995, Cat. no. 9206.0

[a]For 1971 New South Wales includes Australian Capital Territory

Year 5: History—Using Databases to Create Quantitative Data to Develop Narrative Writing

Suggested Implementation: Online database, print based database, Graph paper, writing materials, paper.

Implementation Strategies:

(i) *Use a database of existing statistics of an historical event, or series of events (for example, this could work well when considering convict arrivals, deaths as a result of the Frontier Conflicts, early European exploration tracking, or other significant event that has individualised, human data).

(ii) In groups, students take this data (that may include, for example relevant information such as name, age, race, date of death, reason for transportation, geographical tracking) and create a graph to represent the information. If convict arrivals is selected, the University of Wollongong has published an online database of First Fleet convicts (http://firstfleet.uow.edu.au/search.html). This very comprehensive database has search fields which means that students will be able to define the fields in order to limit the search results, and thus make their task more manageable. For example, a search can be undertaken on *female* convicts, on *all ships*, sentenced *to life* imprisonment.

(iii) Students review the data, and then consider how it can be interpreted from a variety of perspectives relevant to the depth study.

(iv) Students then write an extended narrative (this could be in the form of, for example, a feature article, report, article for a history magazine) reporting on the events, using the graph to inform their writing. This demonstrates to students that quantitative data can be used to create interesting narratives of historical events. They will also need to do additional reading/research so that they understand the deeper context of the event. For example, if investigating the Frontier Conflicts, students could study government policies of the day, newspaper articles, government distributed materials, attitudes of the people of the day, reasons for massacres occurring, Indigenous resistance, and multiple perspectives of different groups.

(v) **Review the different data displays and determine which representation was most effective for the selected data and why.

Question prompts and example lines of inquiry:

Why might different groups have different perspectives on the same historical event?

How can quantitative data be used to write history?

Bringing it all together:

Students produce an extended narrative as evidence that they can 'translate' quantitative data into qualitative writing.

Activity origin: Adapted from an activity originally sourced from: http://www.schoolhistory.co.uk/forum/index.php?showtopic=2847

Differentiation

When the graphs (and table) are finished, students review the results (perhaps even by swapping between groups) and consider questions that remain unanswered to enable further research and inquiry. For example, why a large percentage of soldiers may have died and are buried in the same location; this may say something about the battles fought, the theatres of war etc. This can then develop into a research project where students start with the individual, or, in this case group of individuals (making the history more 'real' to them) and then branching out to cover the broader contexts of that particular conflict, whereby students answer the question that they and their peers have posed.

Australian Curriculum Mathematics Outcomes

(ACMSP147)

Numeracy Links

Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables

comparing different student-generated diagrams, tables and graphs, describing their similarities and differences and commenting on the usefulness of each representation for interpreting the data

Australian Curriculum Subject outcomes and dElaborations

Outcomes:
Identify and locate a range of relevant sources (ACHHS101)
Elaborations: using internet search engines, museums, library catalogues and indexes to find material relevant to an inquiry (for example primary sources such as stories, songs, diaries, official documents, artworks)

Locate information related to inquiry questions in a range of sources (ACHHS102)
Elaborations: using pro formas and datasheets to develop questions, and record information and sources/references

Identify and locate a range of relevant sources (ACHHS120)
Elaborations: Using internet search engines, museums, library catalogues and indexes to find material relevant to an inquiry

The Learning task: Year 6-: Using primary sources to create quantitative data.

Students use enlistment information from during war time to collate appropriate details to construct a graph and a demographic table.

ATSI considerations: There are protocols around showing pictures sharing information and speaking of dead in ATSI cultures. Great sensitivity is advised. Information about ATSI soldiers is available from the websites on the lesson but these include some photographs. Protocols can be seen at: http://www.terrijanke.com.au/img/publications/pdf/14.OxfamAus-AboriginalTorresStraitCulturalProtocols-1207.pdf Death is known as sorry business in many groups.

Strategies to support learners with oral backgrounds: Many of these students are students with refugee experiences and although the wars that these students and their families experienced were not wold wars, the emotional impact on these students may be considerable. Not only have many of these students seen, and perhaps suffered from horrendous violence, they may have seen it inflicted upon family and friends, including those who did not survive. Trauma may not be apparent but may be demonstrated in various misbehaviours, defiance and off task behaviours. It may be distressing for the other students in the class to share the experiences of war as retold by these students. It may be wise to be prepared to support all the students in the class.

Authentic Assessment strategies

Assess each child's contribution and work product in terms of meeting all the outcomes and elaborations.

Bear in mind the factors which may impact on the individual student's capacities to engage fully with focus of the tasks. Depending on context, this may vary.

Variations for students from diverse social contexts: students from various sociocultural backgrounds are going to be influenced by their perceptions of what happened in the War studied. Vietnamese students for example may themselves have different perspectives depending on which part of Vietnam their family originated from. The diversity of family backgrounds, displaced, migrant and families with refugee experiences will impact on the students' view of war. This may be further impacted upon by the knowledge that family who are remain residing in the original homeland are not advantaged by coming to Australia.

Year 6: History—Using Primary Sources to Create Quantitative Data

Suggested Implementation: Computers with internet connect for online database; or a print out of relevant data, graph paper, writing materials.

Implementation strategies:

(i) *Access a database of soldiers, nurses, or other support staff who fought in one of the following or as many as are applicable to your class WWI, WWII or Vietnam (this could be from a local source, if available; from the Australian War Memorial; National Archives of Australia, or other location). This activity works best if the database has each soldier's name, date of enlistment, date of death or date of discharge, rank, age, and any other relevant information that all soldiers' records would contain. This activity also works best if the database is contained to a geographical area or regiment/unit. If no appropriate database exists, students could create their own by researching the details of a select group of soldiers from the same town or suburb (this is particularly relevant for studies of WWI) or a group of soldiers from marginalised backgrounds, for example the Torres Strait Light Infantry Battalion.

(ii) **Working in groups, students collate the details and construct a graph, including a side by side bar graph to display two variables of their choice, and possibly also a table to demonstrate the frequency of the characteristics of the soldiers from the database. For example a demographic table might look like (this information is also available on AIF enlistment/attestation papers): discuss the effectiveness of different representations and give reasons for the assessments

Location of enlistment	**Age at enlistment**	**Place of birth**	**Trade or calling**

Question prompts and example lines of inquiry:

What type of demographic information do you think is important for a historian to emphasise?

Why is a person's 'trade or calling' interesting information to include in a database?

Bringing it all together: To synthesise this activity, have students reflect on the usefulness of databases as a resource for historians. Students to write an extended paragraph detailing how they can use the data they have generated to write history.

Additional resources:

World War I database: This database, published by the National Archives of Australia, in addition to soldiers' personnel records, contains the following:

- First Australian Imperial Force (1st AIF)
- Australian Flying Corps (AFC)—the predecessor of the RAAF

Differentiation:

To extend student knowledge, have them access the following site http://www.studentsfriend.com/feed/topic11.html and provide a critique of the various options provided for writing BCE and CE. Students could then end their critique (providing them with a scaffold to do this will support their learning more effectively) by stating their preference for dating, and why, including the option of developing their own system. For students who are struggling with the numeracy or concept of BCE/CE: Give students who are experiencing difficulty, flash cards with dates written on them and have them put the cards along a timeline in chronological order. An alternative to a video is for students, in groups, to demonstrate their understanding of this concept of time by drafting and constructing a poster (possibly interactive, or on cardboard) that explains the differences between BCE and CE, and that can explain how to count from BCE to CE. The poster can be aimed at school students and displayed around the classroom.

Australian Curriculum Mathematics Outcomes
(ACMSP169)

Numeracy Links

* Identify and investigate issues involving numerical data collected from primary and secondary sources - in this case the issues of historical time.

ATSI considerations

There are considerable cultural differences between Western and Aboriginal and Torres Strait Islander concepts of time. The Dreamtime is an important part of indigenous culture and needs to be explored sensitively in historical understandings of time and significant events. Locally sourced information is the most useful guide to the particular groups of students in the class and n=more general information may be found at http://www.workingwithatsi.info/content/PI_dreaming.

Australian Curriculum Subject outcomes and Elaborations

Use historical terms and concepts (ACHHS206)

Elaborations:

- defining and using terms such as BC (Before Christ), AD (Anno Domini), BCE (Before Common Era), and CE (Common Era); prehistory (before the period of textual recording) and history (the period beginning with named individuals and textual recording)

The Learning task: Year 7: Counting backwards to go forward: Differences between BCE, CE, AD, BC and counting between BCE and CE.

Students learn numerical concepts of sequencing, time, and numeracy to count backwards and forwards between BCE and CE. Students answer a variety of questions to ascertain the level of understandings and demonstrate their understanding by producing a short video, explaining BCE and CE, aimed at school students.

Strategies to support learners with formal English as an additional dialect or language

Concepts of time and significant events may vary between diverse groups of students from backgrounds of oracy. It is wise always to consult with a community member or liaison officer regarding the specific ways in which oral history is explained, transmitted by the poets and storytellers in order to sustain the traditions and beliefs of different tribes, cohorts or regional peoples.

Authentic Assessment strategies

Have the students understood the importance of the equal calibrations on a timeline and its scale?

Have the used the given terms and other culturally appropriate terms to record significant times and events in sequence?

Variations for students from diverse social contexts

Many of these students may also be members of other groups considered but it is useful to point out that the Western/European perspectives of explaining time are not universally consistent either, although they may be used internationally for various economic and travel purposes. The Greek calendar, for example is different to the Gregorian calendar which is internationally used and recognised, but it was derived from the Julian calendar and is still recognised as an essentially Christian calendar, despite the more secular use of the terms Common Era and Before the Common Era.

- Australian Naval and Military Expeditionary Force (AN&MEF)—the combined force despatched in August 1914 to neutralise German New Guinea
- Royal Australian Naval Bridging Train (RANBT)—formed to assist the landing of men and equipment from RAN vessels
- Australian Army Nursing Service (AANS)
- Home or Depot units for personnel who served within Australia
- Non-combatants such as artists, photographers, chaplains and historians

The database can be accessed at: http://www.naa.gov.au/collection/explore/defence/service-records/army-wwi.aspx

Activity origin: Adapted from an activity originally sourced from: http://www.schoolhistory.co.uk/forum/index.php?showtopic=2847

http://www.abc.net.au/news/2014-05-30/calls-to-identify-and-honour-aboriginal-soldiers/5489648

https://www.awm.gov.au/encyclopedia/aborigines/indigenous/

http://www.ww2australia.gov.au/allin/indigenous.html

Year 7: Counting Backwards to Go Forward: Differences Between BCE, CE, AD, BC and Counting Between BCE and CE

Suggested Implementation: The *History for those new to teaching the subject* booklet (optional pre-test, p. 30), writing materials, student notebooks, computer with online access (optional).

Implementation Strategies:

Note to teachers: In teaching this lesson, during the orientation phase, the teacher is to emphasise time, chronology and sequencing as being key disciplinary skills of history (that cross over and features numeracy). This lesson is divided into three parts and can take place over one or two lessons.

Part A: Diagnostic Testing of Students' Existing Knowledge

(i) Determine students' background knowledge by setting them a pre-test on the topic of chronology, dating, and related topics and terms. It is not expected that students will know the answers to all the questions, and what they do know can inform the direction of the lesson.
A sample pre-test can be sourced from the *History for those new to teaching the subject* booklet (p. 30).

(i) After the diagnostic assessment, ensure that all students understand the following terms and their definitions by revising them. Sample definitions:

Time Terminology (i) BC: Before Christ (ii) AD: Anno Domini, 'In the Year of the Lord' (iii) BCE: Before the Common Era (iv) CE: In the Common Era

Part B: Counting Time Between BCE and CE

(i) *Verbally explain to students counting backwards and counting forwards for BCE and CE times. The 'Additional Resources' sections has links to online videos that achieve this succinctly. Consider either showing the videos to students or using the videos as teaching background information.
(ii) For BCE, the earlier the date/year, the bigger the number. For example, the year 356 BCE occurred *before* 25 BCE; whereas in CE, the year 356 occurred *after* the year 25. Ensure that students understand that CE is not always written for years and that where there is no BCE or CE, it can be reasonably assumed the year is CE. Explain it as: 2016 is not written as 2016 CE even though that is its more formal expression.
(iii) Students calculate the differences in years with some simple equations to assess their understanding, for example: (i) 1000–2000 is years, (ii) 1675–1687 is years (iii) 345–154 BCE is years (iv)2035–543 BCE is years (v) 1066–1788 is years
(iv) Continue with equations until students understand the system of counting BCE and CE.

Part C: Constructing a BCE/CE Timeline and Others

(i) *Using a topic of study from the Australian History Curriculum (for example, Egypt, China, India, Greece, Rome or Mass Migration) either provide students with information (perhaps an extended narrative with dates; or a textbook chapter) or have students research information (using online and/or print sources) so that they can create their own timelines showing BCE and CE dates.
(ii) Once completed, students can share their work with a peer so that they can check each other's work and clarify any dates they think are incorrectly placed.
(iii) Develop a timeline that is not based on the Gregorian calendar depending on student ethnicity

Question prompts and example lines of inquiry:

The glossary in the Australian Curriculum: History provides a definition that could be used by the teacher in explaining this dating system; the included 'Time Terminology' glossary also provides this information and could be provided to students as a guide.

Bringing it all together:

In groups, students can demonstrate their understanding of this concept of time by scripting, filming, editing, and publishing a short video that explains the differences between BCE and CE, and that can explain how to count from BCE to CE. The video can be aimed at school students and uploaded on YouTube™ or other internet video sharing site.

Additional resources:

http://www.achistoryunits.edu.au/teaching-history/historical-skills/teachhist-skills.html

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Additional Resources

Resources

http://www.australiancurriculumlessons.com.au/category/history-lessons/

http://achistoryunits.edu.au/home/website-home.html

Professional Reading

http://www.aare.edu.au/publications-database.php/9385/understanding-identity-as-a-teacher-of-numeracy-in-history-a-sociocultural-approach

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Media Arts: Visual Culture and Numeracy

Kathryn Grushka and Maura Sellars

Introduction

The ascendency of a visual culture in the arts, sciences, media and everyday life places the image as a key meaning-making tool (Stafford, 2007). The digital image is now central to both the Arts and the Sciences and core to technology curriculum (Grushka, Donnelly, & Clement, 2014). A focus on Media Arts in the Australian Arts Curriculum (http://www.australiancurriculum.edu.au/the-arts/introduction) acknowledges the importance of a critical understanding of how all images, including media images, express the ideas of their creators. The images may include medical images (X-rays or diagrams), metrological or topographic images, satellite images, Google Maps or personal digital photos and their curatorial elements as they are employed and used to communicate through multiple digital platforms including Facebook or Instagram.

Media Arts, in the Australian curriculum, however is located primarily in the Arts, but connects to the historical study of film. Media Arts is bound by its rich visual culture tradition, expressing the communication of all communities, local, national and global as they connect to other place-based cultural ways of reasoning visuospatial knowledge (Owens, 2014).

The skill of visuacy (Davis, 2008) includes being able to create, process, critique and appreciate all aspects of the visual from advertising to documentary video, through to film or animation with an orientation on the artistic qualities of the media objects. A focus on media studies is also addressed in English curriculum primarily through critical lenses. In the Arts it is through the creative, aesthetic and multiple

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critical lenses (Dezuanni, 2015). The general perception of Media Arts, because of its film and television roots, is that it deals primarily with popular culture representations as they carry socio-cultural messages about identities, gender, race, class, events and histories. While the subject matter of Media Arts is still located in this area it is now broader and can embrace all forms of representation underpinned by digital technologies and their related communication practices.

It deals with still and moving images and the use of sound to communicate as well as educate that connects it directly to the lives of children and their digital literacies. It may include digital games, puzzles, the news, cartoons or animations, video documentaries and web-based search sites such as Google or YouTube. Inside these search engines an entire other world of media can open up from locating artworks or artefacts inside virtual museums, to scientific or medical illustrations as diagrams, videos or interactive programs, animated weather maps of tornados, to videos of tsunamis to goggle maps and advertising interactive sites. In the Arts curriculum area of Media Arts is presented as interdisciplinary understandings that cross between the arts and sciences with visual representations improving the learning (Bobek & Tversky, 2014). It includes leisure activities such as media, advertising, television, film, gaming and the informal/formal digital learning spaces of children and adults. These mediums represent twenty-first century literacy and are underpinned by literacy and numeracy, cultural studies and all art forms.

In the Australian Curriculum, The Arts, Media Arts integrates all the art forms, visual art, music, dance and drama. All of the Arts curriculum areas, particularly Media Arts, are underpinned by the idea of storytelling through communication technologies and the use of digital materials (Dezuanni, 2015). Media Arts, because it is driven by digital technologies, carries many levels of numeracy knowledge and skills and a seemingly endless range of possible applications. Media Arts can embed all of the distinct mathematical ideas located in the numeracy skill sets contained within each art form (see individual chapters for arts discipline specific numeracy) and then combines them according to the technologies of choice (teachers or students) that underpin the selection for the Media Arts area.

The future of Media Arts in the classroom will shift from the camera, all be it the digital camera, to new handheld devices such as iPhones or iPads which embed the camera and its accompanying editing functions. Whichever digital device the student chooses to use or is available to the class, it is critical that the students learn to understand the creative capabilities of their technical device(s). This specifically requires them to understand how to position the camera in relation to their body or the subject they have chosen to capture. This, in turn, necessitates that they understand the limitations of the digital tool and to know their personal skill set in order to negotiate the content and its representational forms. Most importantly, they need to be aware of the audience for whom they are producing the media artwork. Responding to Media Arts, to be able to critically evaluate the design and production effectiveness of the media artwork in relation to the target audience is essential. For example, is it better to take an individual portrait without a background or with one? Is it better for the meaning of an image to include a lot of detail or make the image blurry or black and white rather than coloured? The inclusion or exclusion of certain details about content can often limit or open up possible meanings for an audience. Both aesthetic decisions and critical literacy decisions are present whenever we take images for the purpose of creating an artwork, a documentary or an advertisement.

For the teacher who chooses to consider Media Arts as an area of curriculum with integrative discipline and creative meaning-making potential, it is important to allow freedom to the students when they make decisions about how they choose to represent their concept, subject matter, event or imaginary story. The teacher working within the digital learning classroom can now access multimedia technologies at any time. Knowledge within these new learning environments is seamless and transcends artificial boundaries (Grushka et al., 2014) and the conventional boundaries between the various discipline areas no longer seem relevant for students. Chapman (2015) argues that an arts-immersion is the interdisciplinary strategy most appropriate to break down existing 'silos' of discipline in primary schools. This chapter seeks to support the ideas of Chapman by elaborating on the benefits of using Media Arts and their interdisciplinary affordances to link the arts to the teaching of functional mathematics, specifically as they inform visuospatial reasoning, abstract and metaphoric thought (Grushka, Lawry, Clement, & Hope, 2016). It will elaborate this position by connecting the ideas of Media Arts as interdisciplinary and technologically driven with the ideas of Geiger, Goos and Dole (2015), who argue that the integration of technologies across curriculum builds skills, mathematical knowledge, dispositions and orientates the students towards using mathematics critically.

Thinking in Media Arts

In Media Arts learners are interactive thinkers harnessing the real, material and digital experiences and multimodalities when making meaning or learning by doing (Cope & Kalantzis, 2009). Buckingham (2012) advocates for a learning-technology-by-design approach, where the emphasis is placed on becoming a technological practitioner through creating artefacts. Engaging in Media Arts pedagogies, which are student-centred digital designing tasks, will build technical, practical and critical skills necessary to communicate in the future. Students will learn to produce media, critique their own digital work and the digital world of the Internet, television and games. They will learn to think collaboratively as they design and make. They will learn how to combine the visual, symbolic, auditory and moving image with verbal or written literacy present, but taking a back seat. What is most important to note is that young people produce self-directed arts projects solely because they want to, they make Facebook pages, post onto Instagram and other digital platforms, create personal animations and videos because it is their technological world of communication and this world represents the interests of arts-based learning for children (Peppler, 2013).

Perspectives of Teaching and Learning in Media Arts

Within the Australian Curriculum (ACARA, 2015: 7), in The Arts, Media Arts as making is practical action and critical thought applied to the design and production of media artworks. Students may work independently or collaboratively to experiment, conceptualize, reflect on, refine, present, perform, communicate and evaluate a media artwork. Like the Visual arts, Media Arts require the analysis, illustration, interpretation and organisation of ideas from a range of sources that connect space and reason (Knauff, 2013) such as:

the natural world;
the manmade world of objects and structures;
the world of events;
the quantitative world of numbers, symbols, statistics, percentages;
the world of maps, diagrams and models in maths and science (Ainsworth, Prain, & Tytler, 2011); and
the world of storytelling and the imagination.

Such a broad range of source ideas reveals for the teacher that Media Arts can integrate all curriculum areas in exciting and innovative ways, particularly as Media Arts focuses on communication and presenting different settings, points of view, genre conventions (ACARA, The Arts, 2015: 52). These may include, a video about drought and erosion, a video representing a family event, an animation about my imaginary friend, an animation about the concept of rain or a trip by train. It may also include creating and presenting graphs, maps, edited events as they are shaped by the News on television, or by the structure of online newspapers and other digital reporting genres. It may consider how sound carries mood and volume, such as quiet to loud or crescendo for conclusion.

Underpinning all of these digital genre conventions is the language of Visual Design (see Chapter 'Visual Art, Visual Design and Numeracy' for the application of numeracy in the generation of meaning) and the additional **Media Arts Elements** of:

Composition as faming, editing and layout;
Time, as ordering, duration and depiction of events and ideas;
Space, as distance and relationship between objects, sounds and texts, including numbers;
Sound, as loudness, softness, ambient noise, or music for effect, quickness for anticipation, or how sound carries mood and volume, such as quiet to loud, crescendo;
Movement, as how the student envisages the eye will travel either across a page or poster, between the characters talking or moving in a scene; and
Lighting, light shade and colour for effect.

Each of the above elements carries numerical thinking in their underlying conceptual design. They subsume the 7 mathematical visual tools: maps, diagrams, graphs, tables, charts/flowcharts, timelines (Siemon et al., 2013). To explain or infer meaning from media products students will be required to unpack the numerical concepts present in each of the above elements, identify the appropriate numeracy skills located in the mathematical visual tool sets in order to critically unpack the communicative meanings. For example, they may need to ask:

How has a graph been designed and why was the data on the graph important in advertising a product? Or;
Why did the designer choose to use percentage scales rather than descriptive words? Or;
Why did the designer chose to use a floor plan or a 3-D virtual model of the house in their video for the promotion of new housing web site/Or
When should I access timetables, interactive calculators, quantitative visual metrics, in my research project?
What do these symbols and graphics mean? Do they represent numerical concepts? How can I apply them to my own work?

Mathematical symbols are visual tools and are an aspect of Media Arts. Once a teacher begins to search for the mathematical visual tools in Media Arts they will find endless examples to choose from across all age levels.

The Elements in Media Arts Defined Through the Numeracy Lens

The following section uses descriptive narrative and metaphor in order to elaborate on the visuospatial, abstract and metaphoric reasoning located in Media Arts elements. The story of Alice in Wonderland and other recalled images will be used elaborate on the key ideas as most people have at least one illustrative version of the this story locked into their memories.

Composition: visuospatial reasoning as framing, editing and layout.

Framing refers to the visuospatial decisions we make when we decide what will be included or excluded in an image or picture plane seen by the viewer or audience. These decisions make connections with space and measurement in mathematical reasoning (Lowrie & Owens, 2000). The Media designer might make the decision to have the doorway take up half or more of the picture plane to direct the action (measurement). The decision about how to angle the eye of the audience requires engagement with spatial concepts in order to imply action (the door may open). They may also make decisions about the door being very small and to place the house in the distance to capture the bigger scene or context. Or, the door takes up about a quarter of the height of the picture and I juxtapose Alice's White Rabbit (as big as the page) with the door. The viewer then estimates the door is too small and the White Rabbit will not be able to go through the small doorway;

Editing accompanies framing decisions. Editing requires decisions about detail, context and content in visuospatial relationships as mathematical processes engage with relating position and shape, reasoning and visualising, manipulating screen or hand drawn or physical objects as well as solving and conjecturing (Lowrie & Owens, 2000, p. 181). I may edit out the windows near the door to focus on the door, I may change the colour of the door or I might choose to remove the door and focus on the darkness or brightness of the room into which the White Rabbit wishes to go. In a moving video, the decision may be how many frames per second I need to ensure that the viewer comes slowly to the entrance of the small door to the room the White Rabbit wishes to enter. It engages comparative size thinking, the abstract relationships between the elements. When the designer scripts into the narrative the idea of a size dilemma being foreshadowed for the White Rabbit, it engages visuospatial reasoning. What is the most effective relationship between scale and distance in my design? How effective am I in ensuring that the audience begins to anticipate the consequences that accompany the complexity of scale and space in this moment for the White Rabbit. Did I build anticipation, suspense?

Time: involves understandings of the past, the present and how the future can be represented. These are abstract concepts that operate with visuospatial knowledge. In Media Arts timing refers to ordering, duration and depiction of events and ideas and is present in both still and moving images. I can employ both *framing* and *editing* to build the concept of *time* into my storytelling. The White Rabbit is represented as a long way away. The White Rabbit is small and he is behind the trees and on the hill. In the foreground the house is big but the front door is small. The audience, using the concept of perspective and their knowledge of distance, as time travelled, can interpret that it will take some time before the White Rabbit reaches the house. In the moving image, the frames will be calculated to ensure that real time passes in the experience of the audience, such as one minute to get from the hill to the house. Of course this real time can also be illusionary and abstracted. As in the moving image the frames may be edited to go from day to night, *duration*, yet still only take one minute. The audience sees this as a video that depicted the event of time pasting. It took the White Rabbit an entire night to get to the house.

Space: is the distance and relationship between objects, sounds and texts, including numbers. The White Rabbit may free fall into the hole. The distance from the entrance to the bottom of the hole can be illusionary time and illusionary space. This can be enhanced by the sound of something moving quickly like wind, a stone dropping into water and the length of time it took to hear it land onto the water. Or it may use the visual effects of the sides of the hole as broken lines that move rapidly in an animation, or change colour or tone to enhance this experience. The experience of falling from light to dark… going deeper away from the light as the Rabbit goes further down into the earth. By calculating my frames per minute I can determine how big this space might be.

Sound: as loudness, softness, ambient noise, or music for effect, quickness for anticipation. I use sound to evoke emotional responses to enhance the visual effects I am using as a Media art designer. Sound is represented as duration, time as frames per minute, or as volume, amplification calculated according to a volume scale. The

Media designer using the software comes to know the numerical scale of loudness-softness as a sliding scale in their software. This of course is represented as a visual interactive scale graph.

Movement: can be visuospatial or sound. Movement as visuospatial reasoning, is calculated by considering in the design how the viewers eye will travel either across a page or poster, between the characters talking or moving in a scene.

As sound, it is the loudness or softness as volume or the pace of a piece of music (calculated as beats or counts per minute). The selection and addition of sound and its duration between different points in the framing of a video and accompanied by the manipulation of volume carries mood. Mood is a very important element in Media Arts works.

Lighting: is intensity or the moving between points of darkness and lightness as shades. Lighting employs with visual–spatial movement and sound to extend and enhance the mood of the scene or the music. Lighting enhances sound and colour and together they work their magic in carrying the emotion of the scene.

Apply the Numerical Reasoning and Representational Practices to the Knowledge and Skills in Media Arts Learning

Underpinning any Media Arts practice will be the fundamental world of design thinking as visual, spatial and temporal reasoning (Gero, 2015) and the addition of sounds or music. Each of these ways of reasoning and making meaning involves the practical application of numerical understanding in the same way that drawing is critical to scientific understandings (Ainsworth et al., 2011). Geiger et al. (2015) argues that increasingly digital environments subsume the features and functions of mathematics into their interfaces. Each piece of Media Arts software allows for the manipulation of such digital interfaces as cognitive tools. These cognitive tools enhance the learning and teaching of mathematics as they engage students in problem-solving mathematically. For example, to digitally edit a video we must think in *frames per minute* (duration), and this is graphically represented in, for example the iMovie toolbox. To edit involves calculating how many fames are needed to carry the narrative successfully and which frames can be subtracted to clarify the message or limit the time or duration of a section of the video. The iMovie tool bar allows you to problem-solve applying mathematical ideas interactively. The student can then change the volume of their music on the video by manipulating the sliding volume tool bar. Similarly a student can go to any number of mathematical interactive charts, add their data, create a visualisation of the statistical calculation, save it and then add it to a poster or advertisement. It may be therefore that Media Arts is actually a very successful learning space for application of numerical concepts as it is part of everyday life, an authentic communication space (Carrington & Marsh, 2005) and as Peppler (2013) states, young students' own, personal, interest-driven learning environment.

Conclusion

In summary, the following table elaborates on how the ACARA Media Arts Years 5 and 6 (ACARA, 2015: 50) content elaborations can focus on the numeracy ideas which can be applied when building content to meet interdisciplinary outcomes.

Content descriptor	Elaboration	Numeracy links for meaning-making
Explore representations, setting, ideas, story principles, image genre conventions, sounds and text	Create a humour or action	**Use Photo Elements 14** Take a digital image of yourself Select a digital image from the Internet of a place you want to go to *Using Guided Edits* Select and cut your selfie image. *Resize* it to fit your Internet images, paste yourself into the scene. Write your new adventure
Develop skills with media technologies to shape space, time, movement and lighting with images, sound, text	Create a dance or drama sketch with your friends	Use iMovie Video your dance sequence Add music to create mood, suspense or excitement. *Manipulate loudness, speed, duration* Add title and credits to your iMovie
Plan, produce and present media artworks for specific audiences and purposes using responsible media practice	Create an advertisement to promote a product, sell a product or communicate the success of a product	**Use Photo Elements or Illustrator or Graphical Elements (Maps, charts, statistics)** Access Design and Illustration Tutorials (http://design.tutsplus.com/) Create a character to sell a product Select and colour theme and modify images accordingly, *tonal change* Design the *background areas* of your poster/advertisement, focus on *proportion in layout* Use an interactive chart or other *calculating tool* to present *statistically information* about the product.

(continued)

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Content descriptor	Elaboration	Numeracy links for meaning-making
		Manipulate through *resizing* either the charts, figures, texts, background layout to refine meaning
Explain how the elements of Media Arts and story principles communicate meaning	Compare any of the students works created in the 3 content areas above OR Critically evaluate other Media Arts products	In critical review of Media Arts there is the opportunity to reflect on any mathematical aspects of these activities: size, scale, *proportion, area, scale as emphasis, charts, statistically* information as meaningful/relevant, timing, sound volume, etc.

Of course a teacher focusing on the integration of content from other areas in the curriculum can plan how the mathematically concepts can be explicitly taught in a mathematics lesson and then applied using digital tools appropriate for Media Arts. Alternatively, if a teacher wishes to integrate Media Arts the first consideration will be the Graphical Representations (diagrams and other visual explanations or figures) to be selected that relate to the lesson or unit content. Both are mutually supportive in extending and realising the numeracy competencies of students in classrooms.

Differentiation: This task is focussed on the events in one picture book. Different picture books can be examined and the resolution explained in terms of who this may work for certainly, impossible, likely or unlikely. It is the resolution of the critical event in the story which is the major focus, but many other aspects of the books can be discussed with chance vocabulary, including: Can ducks go for walks in the park? Can ducks climb a rope or hold onto a stick? Do ducks eat sandwiches? Would you see duckling following along after their mother in a single like the ones in book?

Australian Curriculum Mathematics : Numeracy Links

Outcome code and descriptors:

ACMMG006 : Use direct and indirect comparisons

ACMMG009 : Sort, describe and name familiar two-dimensional shapes and three-dimensional shapes in the environment

ACMMG010: describe position and movement

Australian Curriculum Subject outcome codes and indicators. Compare opinions about characters, events and settings in and between texts(ACELT1589) Listen for specific purposes and information, including instructions, and extend students' own and others' ideas in discussions(ACELY1666)using spoken language for problem solving, and exploring ideas and concepts listening for specific information and providing two or more key facts from an informative text spoken or read aloud

THE LEARNING TASK – Media – Foundation- the tree that changes size. In pairs students try the Native Indian method (see video) of finding the height of a small tree or shrub. Students then explore how the size of a tree can appear small or large depending on the relationship between it and other objects in an image. Students create photographs that show this illusion and respond to artworks, designs or illustrations in the media that use illusion of scale to emphasise things. Alice in Wonderland is a great story that plays with this idea and many advertisements and designers use scale for effect such as the idea of the Big Banana.

Including ATSI perspectives This learning is planned to b facilitated through narrative. It connects these students tc the land the characteristics of animals and people. Although the illustrations in the book appear to be Aylesbury, Indian runner or Muscovy ducks, which are not native to Australia, there are many native ducks that have similar habits. These students can easily use the language of chance effectively. https://intranet.ecu.edu.au/__data/assets/pdf_file/0016/510073/8-Aboriginal-ways-of-learning-factsheet.pdf

Strategies to include learners with oral backgrounds: Student in this group traditionally have not interacted with pint materia – either as a reader or a writer. The notion of learning through narrative will be familiar as may be the understanding of ducks and ducklings. It is important that explicit links are made for these students between the print, the oral reading and the illustrations so that these learners are able, depending on their English language competencies, to engage as fully as possible with the ideas and concepts in the story and the chance of these happening. Movement and repeated reading and showir are also supportive strategies for these students. There may be various reactions to idea of being trapped in a hole, so it may b useful to assure students of their safety at school and in the classroom

Authentic Assessment strategies All outcomes and elaborations can be assessed. The maths understandings can be assessed by: observation, sustained academic conversation or product analysis. The Media Arts outcomes and elaborations can be assessed through observation, media product (graphic elements, selection of images), talking about stories images and key ideas, effectiveness of graphics and linear storyline in communicating the key ideas to audience.

Variations for students from diverse social contexts: There may be a huge diversity in the ways in which students typically play (out in the bush, unsupervised, supervised in the outback, on constructed concrete playgrounds, inside with electronic devices, near wildlife and water or at a distance from these etc) so you will get responses based on children's understanding and knowledge of parks, ducks and characteristics. It is important to ask questions in simple straightforward terms initially so that students have access to the learning and to accept answers relating to the problem solving logic and chance in other terms and increasingly clarify during the duration of the lesson.

Media—Foundation

Resources: https://www.youtube.com/watch?v=F6fltSqImFM, paper for recording, coloured pencils for drawing, playground or park with shrubs or small trees Illusion in images: http://visualfunhouse.com/; snapshot illusions http://visualfunhouse.com/category/snapshot_illusions. This web site once explored will open up a range of exciting learning ideas that link art and numeracy more broadly.

This activity can be adapted for any age of students. It is an ideal activity for days when students are in sports uniforms as it is an outdoor activity. Either of the ways on the video can be used but the Native Indian method is simplest.

Discuss: How big are the trees, shrubs in the playground or in the park? Students are only learning about estimating and informal measures, but even as babies, students would have been born with an innate sense of quantity. They may offer imperial or metric measures and the largest number that they can make up, however, this activity is simple using informal measures such as strides, dolly steps and giant steps, and heel to toe.

In addition they informally learn about relative size and scale.

Task 1: Measuring a tree: Outside, in pairs, students try the Native Indian method (see video) of finding the height of a small tree or shrub. One supporting, the other actually looking between their own legs until the can see the entire tree. When they have achieved this they stop. Then they walk back to the tree or shrub using whatever method of travelling the students or the teacher have decided to use. Students count the steps as they go. One pair of students can demonstrate at a time and count together until everyone is ready to have a try independently with their partner.

Compare the sizes of the trees using tall and taller.

Task 2: The illusion of size: Outside, in pairs, students try the Native Indian method (see video) of finding the height of a small tree or shrub. One supporting, the other actually looking between their own legs until the can see the entire tree. When they have achieved this they stop. The children take it in turns with their partner to photograph the tree between their legs. One child stays in the position while the other takes the photo by lying on the ground. The students can then print off their photo after they have located their own teacher-downloaded image in the class file on the computer. They then discuss how the image creates an illusion of scale or size. They can then talk about who is really biggest the student or the tree. They can refer to Bonsai trees as miniatures of reality. Illusion of scale or size is used often when advertising or when the artist or designer is trying to emphasise a message to the audience for impact.

Differentiation With care, other bulbous plants may be gown in this way. Flowering bulbs are useful for this task and other vegetables such as carrot tops and potatoes can be successfully grown on a pad of wet kitchen paper. The potato needs just one 'eye' to be propagated. The plants/vegetables can also be grown in soil with a glass viewing pane that can be uncovered to see what was happening below the ground. A paddle pop stich can be attached to the top of the jar and the length of the shoots predicted and measured also.

Australian Curriculum Mathematics : Numeracy Links

ACMMG019: Measure and compare the lengths and capacities of pairs of objects using uniform informal units Understanding that in order to compare objects, the unit of measurement must be the same size. Students can have individual projects for this task or share with a partner.

ACMMG021: Describe duration using months, weeks, days, hours. Activities can be made more complex by continually questioning the students about their reasoning and suggestions regarding why the experiment was organised in this way and by having students predict what may happen or setting a line on the measuring paper and predicting how long the roots would take to reach the mark.

Australian Curriculum Subject outcome codes and indicators. Living things have a variety of external features (ACSSU017); Identify common features of plants such as leaves and roots. Stories of growing things (ACAMAM054); Photograph or video the documentary story of an onion or other plant (ACAMAM055); Create an imaginary story of a plant that grows and affects our world. (ACAMAM056). Respond to other media works (ACAMAR057). Jack and the beanstalk or stories about co-dependence of plants and animals

THE LEARNING TASK – Media – Year One – plant growth
Create a story about the life of a plant that grows to help the animals that live in its environment. The key idea is to communicate growth (the life cycle of thing- death and renewal, new growth) and the interdependence of living things. Students are to draw on their documentary evidence of how things grow to help them illustrate the story. Leaves grow, curl and dry out and spiders make their homes in dead leaves. Dead leaves decay (get smaller) go to the earth and new things grow. The key connecting focus will be scale and measurement. The leaf is bigger than the spider.

Including ATSI perspectives: depending on context, many students may be very adept at understanding the growth process and have a good understanding of conditions for growth on the land. The class may like to ty and grow a native vegetable like the native leek http://www.abc.net.au/gardening/stories/s3587731.htm or other native rhizome or tuber.

Strategies to include learners with oral backgrounds

Some students may be uncomfortable about using food for experiments so it may be wise to select one of the other methods of growing and measuring if you think this issue may affect your school community. Potatoes and sweet potatoes can be planned in a terrarium o in the garden and a glass viewing panel constructed that can be accessed to reveal the root growth. The measuring is more complex but can be done by making marks on a piece of string. The class might like to select a vegetable from these students' homelands to try and grow

Authentic Assessment strategies. All outcomes and elaborations can be assessed. The maths and science understandings can be assessed by: observation, sustained academic conversation or product analysis. The Media Arts outcomes and elaborations can be assessed through observation, documentation as digital image or drawing, talking about stories that illustrate the key ideas, effectiveness of drawings to communicate ideas to audience.

Variations for students from diverse social contexts

Once again the use of food may be problematic but the options for other planting and measuring growth that produce a harvest can be selected if you feel that this may be problematic in your context. Some students may not have gardens or access to the facilities for growing anything, so this may be a different experience for them. Some students are not aware of food sources or how different types of food are produced. It may be possible to develop this activity into a school garden and have some fruit or vegetable that is easily grown in your area as the year one section for your class.

Media—Year 1—Growth

Resources: one onion per student, one glass jar per student, one strip of paper per student, four toothpicks per student. iPAds or digital cameras, drawing materials. Scientific illustration and artistic images of plants growing (and dying). Imaginative stories such as Jack in the Bean Stalk can extend the ideas of growth.

Media Outcomes and numeracy concepts are to be integrated. Learning should be displayed along the idea of a science/art museum. Consistency in the dimensions of drawing paper and photographs can support discussion about the relative nature of scale. For example, my plant is now bigger than it was before in my previous photo or drawing.

Discuss and Document: Growth in plants over time. Children focus on observation, measurement and documentation of stages in growth. Drawing and Photographs, with the addition of scale approximation markers… consider the idea of sequencing their drawing of images.

Reflective Questions are asked over time and may include:

- How do you know if a plant is growing?
- What signs can you see? What signs did I include in my illustrations/drawings. What signs do other artists put into their illustrations to tell me that a plant is growing? Are illustrations the same as photographs?
- Apart from what you can see above the ground, is anything else happening we cannot see? How do illustrators/artists show you cannot see in their images?
- Students can explain their answers and interpretations.

Task 1: Proving that growth takes place under the plant as well as above it.

Experiment: After the first step, it is best to: (i) Taking the paper strip, write your name on it and glue it to the side of the clear glass container vertically (ii) Select an onion and stick the four tooth picks evenly around the middle (circumference) (iii) Select a jar for your onion. The top of the jar should not allow the onion to fall into the jar (iv) Take your onion out and fill the jar up just far enough so the onion and the water are not touching (v) Watch over the next few days as the onion sends down roots to seek out the water (vi) Do not top up the water, let the roots grow down into the water (vii) Place a mark on your paper strip each day to show where the longest root has grown to (viii) It does not matter if the roots touch the water but as the onion grows green shoots up and roots down, it will actually shrink in size. The students need to try and explain: i) why this has happened as part of the understanding of what is in a bulb, tuber or rhizome and ii) what it does (ix) Ensure that the toothpicks are keeping the shrunken onion out if the water. Replace toothpicks if needed (x) Discuss the growth and use uniform informal measures to record how far the roots had grown each day.

Differentiation: This task is focussed on the events in one picture book. Different picture books can be examined and the resolution explained in terms of who this may work for certainly, impossible, likely or unlikely. It is the resolution of the critical event in the story which is the major focus, but many other aspects of the books can be discussed with chance vocabulary, including: Can ducks go for walks in the park? Can ducks climb a rope or hold onto a stick? Do ducks eat sandwiches? Would you see duckling following along after their mother in a single like the ones in book?

Australian Curriculum : Numeracy Links

ACMSP047: Identify practical activities and everyday events that involve chance. Describe outcomes as 'likely' or 'unlikely' and identify some events as 'certain' or 'impossible . (ACMSP047) Classifying a list of everyday events according to how likely they are to happen, using the language of chance, and explaining reasoning.

This is a teacher led activities with many opportunities for students to contribute their thinking and reasoning around the events in the selected story.

Australian Curriculum Subject outcome codes and indicators. Compare opinions about characters, events and settings in and between texts(ACELT1589) Listen for specific purposes and information, including instructions, and extend students' own and others' ideas in discussions(ACELY1666)using spoken language for problem solving, and exploring ideas and concepts listening for specific information and providing two or more key facts from an informative text spoken or read aloud

THE LEARNING TASK – Media – adaptive reasoning using chance vocabulary

Including ATSI perspectives: This learning is planned to be facilitated through narrative. It connects these students to the land the characteristics of animals and people. Although the illustrations in the book appear to be Aylesbury, Indian runner or Muscovy ducks, which are not native to Australia, there are many native ducks that have similar habits. These students can easily use the language of chance effectively. https://intranet.ecu.edu.au/__data/assets/pdf_file/0016/510073/8-Aboriginal-ways-of-learning-factsheet.pdf

Strategies to include learners with oral backgrounds: Student in this group traditionally have not interacted with print material – either as a reader or a writer. The notion of learning through narrative will be familiar as may be the understanding of ducks and ducklings. It is important that explicit links are made for these students between the print, the oral reading and the illustrations so that these learners are able, depending on their English language competencies, to engage as fully as possible with the ideas and concepts in the story and the chance of these happening. Movement and repeated reading and showing are also supportive strategies for these students. There may be various reactions to idea of being trapped in a hole, so it may be useful to assure students of their safety at school and in the classroom

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Task 2: Documentation using digital images, drawing and approximation scales. The students need to only remember that their eye view or angle and the distance from the plant need to be relatively the same over time when documenting. The teacher can organise chairs and tables to facilitate this. Behind the onion you can have an object that does not change overtime. It can be a toy or it could be a ruler. This allows the students to compare the size of the onion as it shrinks to an object that does not change.

Creative Ideas: Life cycle of life, growth and death. How plants change size within the cycle. Create an imaginary story of a plant that grows and affects our world. Respond to other media works such as scientific illustration or imaginary images about plant growth. Jack and the beanstalk, or stories about co-dependence of plants and animals, and their relative sixe. A small spider can live in an old crumpled leaf.

Media—Year 2: Representing My Story

Resources: One strip of thin cardboard per student width approximately 10 cm (the length of the cardboard depends on the ages of your students. If your students are aged 7 years and 8 years when rounded up to the nearest year, then 56 m or even 28 cm are appropriate) it is important that students have an even number of centimetres for the measuring and folding. It is important that all the students know what each part will measure. *Photographs* (scanned or digital) that can be cut and pasted so parents may not want them back so they need to be aware of this. A pre-prepared chart if necessary showing ages and measurements, Computer, Microsoft Office, PowerPoint. Media works that capture visual stories, e.g. The Arrival Shaun Tan. https://www.youtube.com/watch?v=AtPz4SPwHkw. The images to be analysed for experiences and emphasis, big ship small person. How to represent scale through drawing.

View: media works that carry storylines and emphasis events, arrival or birthdays.

Discuss: Personal history, analysed through the organisation of personal photographs representative of time passing. This will preface inquiry into my identity, my place(s) and other communities, questions might include: What things do you remember as being really important for you? What might have been important for you when you were a pre-schooler? What stories do you know about when you were a baby? When you were a toddler? How old are you now? (students may not wish to round down, but they can all round up if they are more than half a year since their last birthday) Where were you born?

Task 1: Linear timeline: The strips of cardboard have to be shared/divided equally into the age you are in years. There may be a pre-prepared chart of the measurements on the Smartboard for the different ages in the class if the teacher

Differentiation The many different cultures represented in suitable story books give a wide range of opportunity to select appropriate books for this activity. The grids that are developed are also an opportunity for making the task simpler or more complex depending on the students in the class. Allowing students to select their favourite picture book for this task allows for some students independence. The random selection of the coordinates may allow students to observe aspects they may otherwise have overlooked.

Australian Curriculum Mathematics : Numeracy Links

ACMMG085 : Create and interpret simple grid maps to show position and pathways (ACMMG065)

ACMMG064: Identify angles as measures of turn and compare sizes in everyday life.

Apart from the initial instruction regarding the task, the students are in control of the activity and simply require mentoring. The students can work in pairs with the book but they can also work independently with a particular book if they wish. The variation in the complexity of the grid co-ordinates allow students to work at a suitable level. This lesson can connect to other place-based cultural ways of reasoning visuospatial knowledge and narrative journeying.

Australian Curriculum Subject outcome codes and indicators. Discuss texts in which characters, events and settings are portrayed in different ways, and speculate on the authors' reasons (ACELT1594)

Reading texts in which Aboriginal and Torres Strait Islander children/young people are the central characters/protagonists and making links to students' own lives, noting similarities.

Reading texts from other cultures.

THE LEARNING TASK – Media – Year Three – mapping

Including ATSI perspectives: Mathematical understanding and notions of numeracy competencies are culturally determined and spatial concepts are included. The texts selected for class selection need to include ATSI picture books which contain stories about places and descriptions of places. http://www.network-ed.com.au/primary/indigenous/a-is-for-aunty-9780733308727 A is Aunty by Elaine Russell is a good example of a suitable text.

Strategies to include learners with oral backgrounds

The visual, pictorial elements of this task make it an ideal way in which to introduce more formal ways of determining position. Depending on the background of your students it may be appropriate to find books that contain visual images of their original homeland and encourage to describe what they see in their grid as part of a narrative song or poem. Ideally, they would share these books and narratives with the class. The texts should be available to all students in the class

Authentic Assessment strategies

Variations for students from diverse social contexts

It may be useful to get the students to describe how they (and their parents or caregivers) get directions to somewhere new and find their way there. Irrespective if these suggestions contain inefficient or unusual ways of knowing and finding directions, all suggestions are acceptable. People frequently and unconsciously reflect their person interests when giving directions using places that interest them, for example schools, churches, pubs etc. the selection of texts should include those with cultural and social diversity thinks this is necessary. Many students will be able to work it out for themselves: (i) Ask the students to measure the strip of cardboard and then work out what size each piece would be if there was one section for each year of their lives (ii) When each student has decided on the size of the sections, measure and mark along the top if the strip so that each section is the same and there is nothing left over at the end (iii) Then do the same, marking the bottom of the cardboard (iv) When this is completed, ask students to match the top and bottom marks (they can draw with a pencil and ruler and join them if they wish) (v) Then they can fold along the markers so they have one section for each year of their life and they are all the same size (vi) Students can write and draw (or stick photographs for) one extraordinary/funny/ special experience on each section of their personal history timeline, naming the place that it occurred.

Media Task 2: Create a visual PowerPoint based events or things that have been important to you.

(i) Collect photographs from home of you and your family (ii) *Organise* them into important and less important events (iii) *group* them, then *select* and *arrange* them so that they represent a timeline (iv) You can have 3 photographs together, relative size is not important at this stage (v) If the photographs cannot be cut up, scan and print them. (vi) The digital PowerPoint—Storyline can be created in its paper material form, or in the digital form depending on resources. If time allows a material manipulation, cut, paste and glue is always a good first step. Then scan the completed pages into the computer and then it is a simple cut and paste to make them digital slides. At this point or in the previous material form you can consider some key words.

- Creative ideas:
- Consider the audience viewpoint lens. Let the student reorganise their images in PowerPoint according to the ones they remember as most to least important. Organise them in order of your mothers or siblings' memories. This will tell a different story to the story by birthday.
- Consider a theme for your slides based on images selected by the students.
- Consider ideas such as community, travelling, identities, family or others that suit the students' worlds.

Media—Year 3

Resources: Picture books that are heavily illustrated (some suitable titles would include the Where's Wally series by Martin Handford, some of Grahame Base's work and the series from….

Local maps: Google Maps, Whereis, historical maps of local area, old maps, particularly maps with images, such as hills or landmarks or treasure map pictures. https://www.google.com.au/search?q=real+treasure+maps

Differentiation

The task can easily be differentiated by having the students explore the size of the frog and the relationship to the pressure or force that may be needed to make it move. Does a frog half the size jump have as far? Does a frog twice the size jump twice as far? Explain the variation in discus the relationship between size, pressure/force and distance travelled. Toy cars /trucks etc. without any mechanical parts (wind up, batteries etc.) can also be explored.

Australian Curriculum Mathematics : Numeracy Links

ACMSP092: Describe possible everyday events and order their chances of occurring (ACMSP092)

ACMSP093: Identify everyday events where one cannot happen if the other happens.

Students conduct guided exploration with the opportunity to develop their independent ideas, propose hypotheses, conduct the investigations and consider their findings. This can be done independently, in pairs or in small groups with teacher support, mentoring and suggestions.

Australian Curriculum Subject outcome codes and indicators: Forces can be exerted by one object on another through direct contact or from a distance (ACSSU076) Observing qualitatively how speed is affected by the size of a force.

Images, stories and sounds carry ideas (ACAMAM054) and media digital technologies are used to support the story (ACAMAM055)

THE LEARNING TASK – Media –Year 4
Create a storyboard about the life of a frog who experiences an event. The event could be environmental such as drought, fire, heat, flood; a science concept such as reproduction or metamorphosis; surviving in a man made environment such as living in a dump or garden pond. The focus has to remain on the key idea they want to communicate to the audience about the frogs experience, how these forces impact on the jump and the impact of the event for the frog and/or the environment or society.

Including ATSI perspectives: Many ATSI students and others will be able to relate the jumping frog to real frogs and their capacity to jump, to traditional legends and dreamtime stories about frogs and to other Australian fauna such as kangaroos and wallabies. All students may like to decorate their frogs using traditional art forms if appropriate in your context https://www.youtube.com/watch?v=0y3Ta5xcKV4 , http://www.sacred-

Strategies to include learners with oral backgrounds

Frogs are found in all continents except Antarctica http://www.msichicago.org/scrapbook/scrapbook_exhibits/frogs/facts/ . This increases the potential for inclusivity in this science lesson, although these students may not be as familiar with the technology included in the media task, they may be able to talk about the frogs that are native to their environment in Australia or in their former homeland. They can colour and discuss their frogs and what they are doing as a demonstration and an accompanying recording or video

Authentic Assessment strategies: All outcomes and elaborations can be assessed. The maths and science understandings can be assessed by: observation, sustained academic conversation or product analysis. The Media Arts outcomes and elaborations can be assessed in the same way and by using media assessment of the key ideas, the ability to apply the technical skills and the effectiveness of the animation for the audience.

Variations for students from diverse social contexts

Students in city school who may not get out into the areas where frogs are most prolific may benefit from a visit to a nature park or from exploring http://www.msichicago.org/scrapbook/scrapbook_exhibits/frogs/facts/ . This may also be the case for students in desert regions who have limited experience of the movements and the actual ways in which real frogs travel. In some countries frogs' legs are eaten as a delicacy, in Asia, fogs are eaten alive after being disembowelled at the table so it may be wise to anticipate discussion around this and the responses from other students.

+pictures&sa=X&biw=1502&bih=627&tbm=isch&tbo=u&source=univ&ved=0ahUKEwjOl9iZyNDJAhWHJpQKHaD8A7QQ7AkILw.

Clear film sheets with a mapping grid of appropriate scale with both axes labelled. Containers with laminated letters (upper case) and numbers (separate containers, one of each type for each small group or pair) paper for drawing on or books for recording descriptions—or both.

Large art paper, coloured pencils, inks, scissors, paint.

Discuss: Finding places or positions, using grids. Questions might include:

- When might you have to get to a specific place or position? (team games, travel, bus stop, place where they get picked up from sport, dancing, etc.)
- How do you know where they are? What are the key landmarks, or visual clues?
- If you are looking for somewhere you have never been before and your electronic device (satellite navigation aid) is not picking up any signals, what could you do?
- What could you do if they had changed the route you usually take because of road works?
- How do you read a map?
- How might you find anything on a page?

Task 1: Ask students to:

- Select a page from a local map they are sharing with their partner.
- Place the grid over the page.
- Randomly select a number from one container and a letter from the other.
- Find the grid reference.
- Describe or draw what they can see at that reference on their selected page.
- Take turns to choose the pages and references.

Task 2: Create a visual treasure map from your local area and tell a story.

- Using the skills from Task 1, locate a grid references that could contain a treasure. A treasure could be a favourite take away, skate park, beach, picnic area, walking trail, home. It will be imaginatively elaborated.
- Enlarge your grid reference area of your special location from the local map. Freehand draw it to a bigger scale. In the style of the old maps, illustrate how to get to the treasure.
- Write the story that goes with the journey you travel in your imaginary map based on a local landmarks.

Media—Year 4

Resources: Green Paper, http://www.youtube.com/watch?v=Dug196tronQ, black textas for drawing eyes. Digital camera, camera stand and remote switch if available; cardboard box painted white inside, a strong artificial light (lamp), computer, image software.

Make a simple study board https://www.youtube.com/watch?v=iZUojirTEgM.

How to make a stop motion animation using lego: https://www.youtube.com/watch?v=CBdSDynaV3Q.

Simple flipbook https://www.youtube.com/watch?v=Z60hRCKyfH0.

Task: Create a stop motion animation of a jumping frog.

Watch the YouTube video once though. Watch again and make the frog, stopping at each stage so that the pace is suitable for the students. Using the frogs, students:

- Make the frogs jump high
- Make the frogs jump the furthest distance possible
- Have frog races
- Make the frog flip over backwards

Discuss: Where exactly was pressure put on the frog to make it do each of the different movements? Questions might include:

- How much pressure/force do you need to put on the frog to make it (i) jump high (ii) travel as far as possible (iii) flip over?
- Which finger do you use to make the frog move? Why
- Have you tried other fingers to put pressure on the frog?
- Do you put pressure/force on the frog in slightly different places to make it move differently?
- Will the frog move alone without any pressure/force?
- Are there other ways you can use pressure/force to make the frog move?
- What other things might you play with that need you to apply pressure/force to make them move?
- Design a board game that requires you to use different pressure/force to make the frog move in different ways
- Predict what is likely to happen, what has no chance of happening, what is unlikely, likely and list from least likely to most likely to happen

- Imagine an environment that your frog may live in. Consider why it needs to jump and repeat your stop motion now with a storyboard focus.

Task 2 Media Arts Stop motion video of a story about a frog.

- Draw frogs from real life, record real frog sounds or find them on the Internet
- Draw where frogs live, find interesting places frogs live at you house, take a photo
- Find stories or videos about frogs from different cultures Aboriginal Dreamtime stories, Africa stories, traditional/mythological stories from northern Europe, contemporary stories, particularly sustainability stories. Respond to these in terms of story, backgrounds and sequencing
- Video frogs jumping
- Find advertisements or products in the supermarket that use frogs. For example Freddo Frogs
- Make paper mache frogs for your video, or find plastic toy frogs that can be manipulated
- Create a stop motion video, where the action takes place in a cardboard box that has been set designed by the class group based on a collaborated story

Differentiation This task allows for basic weaving in stripes with simple addition of factions with the same denominator and ample opportunities for more able students to develop fractions to express the insertion of different patches of colour. For students who are extremely capable, there the chance to create a symbol for the class that represents the creation of symbol and calculate the algebraic expression for it.

Australian Curriculum Mathematics : Numeracy Links

ACMNA107: Describe, continue and create patterns with fractions, decimals and whole numbers resulting from addition and subtraction(ACMNA107)

Once the learning tool (the loom) has been created, the learning task is open ended. Students may choose the level of complexity of their work and of their algebraic expressions. Many students of diverse backgrounds may be familiar with the notion of artwork and conceptual symbolism on clothing or fabrics. The Video media task

Australian Curriculum Subject outcome codes and indicators.

Respond to media works, artworks, videos, films that link to students' own lives (ACAMAM054) ACAMAR057). Create media maps through drawing and media technologies. Apply grids to build navigational clues add images and words to maps. (ACAMAM055); Select sections of the grid, rework to ensure an audience or event focus (ACAMAM056)

THE LEARNING TASK – Media – Year Five- Create a How to Do it Video for a woven symbol

Including ATSI perspectives The notion of mathematically expressing their practical work may be challenging for some students in the class. All students may benefit from watching then doing, so modelling will help the leaners. The inductive reasoning process used here can support the learning of a wide range of students. http://newlearningonline.com/literacies/chapter-1/eight-aboriginal-ways-of-learning

Strategies to include learners with oral backgrounds

The visual, practical elements of this task make it an ideal way in which to introduce more formal ways of expressing mathematical notation. The notion of making something useful (a bag, a place mat, a table runner) that they have designed themselves may easily motivate them to engage more readily. The step by step process of working with their product may help them develop a narrative around their learning and tap into some traditional skills that are part of their background. Barring physical impairment, because of which the students cannot physically weave, the considerations of cultural roles of weaving may challenge some male students as often this would be women's work.

Authentic Assessment strategies

Variations for students from diverse social contexts

Some students do not engage in practical creative activities, nor do they have a tradition of creating artefacts to meet their personal wants or needs. The challenge for many students may be to view this activity as an authentic learning opportunity that has many levels of learning. For students with restitched linguistic codes and interpretations, the direct instruction involved in making the learning tool should be supportive and explicit, allowing the students to gain an understanding of how to use the practical product to express the pattern as the symbolic, mathematical representation of fractions.

Media—Year 5: Create a '*How to Do It Video' Making a Weaving Symbol Project*

Resources: 1. Weaving on a Cardboard Loom (version 2) https://www.youtube.com/watch?v=LbtKnvc_9No, one piece of firm cardboard per student (stout cardboard boxes are ideal for cutting up to make these cardboard looms), wool, lids of pens to weave with instead of bodkins, paper or books to record the algebraic formulae the students have woven, scissors, large needles, paper, textas. **2. Media Resources**: Digital camera, camera stand and remote switch if available How to Make a Shaker Cheese Basket: https://www.youtube.com/watch?v=psHmWNielcw.

How to make a Duct Tape Beach Bag: https://www.youtube.com/watch?v=X4XDw_oE5AI.

Video Lesson: http://www.australiancurriculumlessons.com.au/2014/03/22/media-arts-lesson-class-camera-part-1-2-year-3/ Visual Patterns: http://www.australiancurriculumlessons.com.au/2013/06/26/visual-arts-lesson-the-nanduti-lace-by-griselda-gonzalez/.

Task 1: Watch the YouTube video and make the cardboard loom (i) Taking one piece of cardboard each, students decide on the number of warp strings they would like to make on their loom (10 is about the minimum, 15–20 is quite effective) (ii) Measure the cardboard into the required number and mark the cuts at the top of the cardboard (iii) Measure and mark the bottom of the loom in the same way, make the cut so they correspond to each other top and bottom (iv) The warp can be attached in two ways. One: simply place the wool over the first cut, leaving a long tail at the back, go straight down to the corresponding cut, come up the back and over the next cut and repeat until all the warp are in place, then join the two long tails at the back. Two: instead of going all the way down the back each time, go down the front and then loop around to the next cut, only going down the back at the finish to tie off the two long tails.

Task 2: Watch the YouTube video again. Then students begin their weaving (it is a good idea to cut longer tails than shown in the video so they can be woven in at the back to finish off). When students have a sufficient amount of weft on the card, they write down their pattern using algebraic notation. (i) The first colour used is a, the second is b and so on. For example, if the warp is 12 and there are 9 rows of green followed by 8 rows of white, the expression would look like this $(9 \times a$ $12) + (8 \times b \times 12)$ OR $\left(\frac{9a\times 12}{17} + \frac{8b\times 12}{17}\right)$ so the pattern stripes can be represented as a pattern of fractions, using the total number of weft as the denominator (ii) Algebraic expressions can be exchanged with peers to see if they can replicate the weave pattern from the algebra—first the simple, then the fractional expressions (iii) Students can progress to logically working out the ways in which a patch or section of a different colour can be expressed as part of the pattern, remembering that in a 12 warp loom, the different coloured sections use one warp twice to avoid making a gap in the weave (iv) To finish the weaving off, cut the warp strings and gather into small, even bunches and tie together with a knot for a fringe. If no fringe is needed, then weave loose ends carefully into the back of the weaving.

Task 3: Media task has three phases.

1. Research and Design: Symbol design based on a study of cultural or flag symbolism, simple geometric design and colour symbolism. 2. Art and Design Task: Create a weaving of your symbol on a cardboard loom. Deconstruct your steps as you make you algebraic formula of your design. 3. Media Task: Create a how to do it video for your classmates in pairs or small teams. To do this: 1. Watch the YouTube videos as many times as you like to decide on the best way to teach another person how to make your woven symbol. 2. With your audience in mind create a short video for your classmates who are your audience.

Discuss:

1. How you could organise your 'How to do it Video' using a mathematical perspective or language?
2. How can the key mathematical ideas be represented in your video?

Media—Year 5

Resources: https://www.youtube.com/watch?v=LbtKnvc_9No, one piece of firm cardboard per student (stout cardboard boxes are ideal for cutting up to make these cardboard looms), wool, lids of pens to weave with instead of bodkins, paper or books to record the algebraic formulae the students have woven.

Task: Making the cardboard loom.

- Taking one piece of cardboard each, students decide on the number of warp strings they would like to make on their loom (10 is about the minimum, 15–20 is quite effective)
- Measure the cardboard into the required number and mark the cuts at the top of the cardboard
- Measure and mark the bottom of the loom in the same way
- Make the cut so they correspond to each other top and bottom
- The warp can be attached in two ways. One: simply place the wool over the first cut, leaving a long tail at the back, go straight down to the corresponding cut, come up the back and over the next cut and repeat until all the warp are in place,

then join the two long tails at the back. Two: instead of going all the way down the back each time, go down the front and then loop around to the next cut, only going down the back at the finish to tie off the two long tails

- The first method gives the length at the back so a long fringe can be made, the second method only gives a short length of wool to work with in the finishing off and can be fiddly to manage.

Task: Watch the YouTube video. The second time, students are to begin their weaving (it's a good idea to cut longer tails than shown in the video so they can be woven in at the back to finish off).

- When students have a sufficient amount of weft on the card, they write down their pattern using algebraic notation.
- The first colour used is a, the second is b and so on.
- For example, if the warp is 12 and there are 9 rows of green followed by 8 rows of white, the expression would look like this $(9 \times a \times 12) + (8 \times b \times 12)$ OR $\left(\frac{9a \times 12}{17} + \frac{8b \times 12}{17}\right)$ so the pattern stipes can be expressed as a pattern of fractions, using the total number of weft as the denominator.
- Algebraic expressions can be exchanged with peers to see if they can replicate the weave pattern from the algebra—first the simple, then the fractional expressions.
- Students can progress to logically working out the ways in which a patch or section of a different colour can be expressed as part of the pattern, remembering that in a 12 warp loom, the different coloured sections use one warp twice to avoid making a gap in the weave, so the warp total would be 13.
- To finish the weaving off, cut the warp strings and gather into small, even bunches and tie together with a knot for a fringe.
- If no fringe is needed, then weave loose ends carefully into the back of the weaving.

Differentiation

For students who may find this difficult to manage physically, the loops can be premade or the entire triangle premade but the problem solving component of the task is then compromised, although the learning about triangles and the manipulation is not. The links to the clues need to be made explicit for some students so they can understand the 'reasoning' aspect of the problem solving construction task.

Australian Curriculum Mathematics Outcome code and descriptors Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (ACMMG141)

Identifying the size of a right

Pedagogical Strategies

Students are working independently, in pairs or in groups to solve the construction problem. There other solutions to the problem that involve tearing the strips vertically and leaving the ends intact but this solution is not as robust a model and does not have the same flexibility BUT all suggestions and attempts are acceptable and should be discussed and defended in terms of the criteria.

Australian Curriculum Subject outcome codes and indicators.

Respond to media works, artworks, videos, films that link to students' own lives (ACAMAM054) ACAMAR057). Create media maps through drawing and media technologies. Apply grids to build navigational clues add images and words to maps.

THE LEARNING TASK – Media –Year 6 Moveable and illusionary Triangles

On completion of a lesson on making movable triangles the students create a video or stop motion animation that explores Eschers ideas about impossible triangles and other constructions.

Including ATSI perspectives

These students are often very adept at problem solving. The class may enjoy watching how a group of men solve their mechanical problems with a car in the bush. https://www.youtube.com/watch?v=H-tsKPlDn7U it may be wise to view beforehand to assess the suitability for your class, but the problem solving strategies are very creative and practical.

Strategies to include learners with oral backgrounds

This task is a practical task and requires what these students frequently demonstrate as part of their background – a flair for creative problem solving and practical intelligence skills. Embedding the task in a narrative can give purpose and can engage the students in the conceptual understandings that are important for geometric reasoning.

Authentic Assessment strategies

All outcomes and elaborations can be assessed. The maths and science understandings can be assessed by: observation, sustained academic conversation or product analysis. The Media Arts outcomes and elaborations can be assessed in the same way and by using media assessment of the key ideas, the ability to apply the technical skills and the effectiveness of the animation for the audience

Variations for students from diverse social contexts

Many students may not have been required to make/ construct items for general use or play. They may also have had limited experiences in classrooms to think, develop and explain their own ideas and experiment. Other students may be more practical in their approach if they are accustomed to creating and modifying a variety of materials to construct an item that satisfies their purpose. Some students may be experienced with using technology only for construction and so the responses to students when asked to engage in this problem solving task may vary, as might the degree to which the students can follow the clues and reasoning.

Media—Year 6. Moveable Triangles

Resources: long strips of paper/thin cardboard, about 1 cm–8 mm wide, four for each student.

Task: Construct a moveable triangle making sure it meets the following criteria:

- No additional materials are to be used (no sticky tape, fasteners. paper clips, etc.) only the four strips of paper/thin cardboard
- The triangle must be able to be picked up and moved without falling apart—the construction must be robust
- The sides of the triangle must all be able to move independently to show each different type of triangle and hold that shape independently.

Discuss: Questions might include:

- How many sides has a triangle?
- How many strips of paper/thin cardboard do you have?
- What might you need the fourth strip for?
- What do you not have that you might need?
- Allow students to discuss all the options they can think of to solve the problem of construction to the criteria. The construction details are below so students can be supported if they get into difficulty.

Construction

- Take the fourth strip of paper/thin cardboard and carefully tear a piece off that is long enough to make a generous loop around the other pieces and have enough to overlap at the ends
- Gently tear the loop horizontally for about a centimetre at each end
- Overlap and interlace the torn pieces so that the loop stays closed
- Repeat so there are two loops
- Undo the interlacing of one of the loops, and holding the closed loop with the open end up, thread the paper/thin cardboard of second loop though the first loop and then redo the interlocking
- This looks like the beginning of an old fashioned paper chain
- Thread through one of the strips reserved for the sides of the triangle and thread another side through the accompanying loop
- Crease into place on the triangle sides
- Repeat twice more so that all the sides of the triangle are attached but are able to move independently
- Crease and fold the tops of the sides of the triangle so that the ‘fasteners’ cannot slide off
- The inside of the framework shows the triangle type that you make
- Students may need an additional strip of paper/thin cardboard depending on the original length

Differentiation: Cardboard strips can be added to name the triangles being, investigated, described or classified in order to verify the properties of their sides and angles. Meccano strips and screws can be used to make the quadrilaterals as another method of exploration and naming. In the media an animation task offering linear or solid ways of constructing and problem-solving the properties of triangle provides choice. Additional activities could find the student adding a Lego figure into the stop motion digital animation in order to explore internal and external spaces, angles and gradients.

Australian Curriculum Mathematics: Numeracy Links

ACMMG164: Investigate the conditions for two lines to be parallel and solve simple numerical problems using reasoning.

The open-ended activity provides opportunities to explore quadrilaterals, squares, rectangles, rhombus, trapezoid and parallelogram and discover open ended solutions through geometric reasoning. The manipulation and construction of 3-D forms is a 'bridging' tool between solid discrete concrete materials and the two dimensional representations that are found on paper. Students can practice the description of the shapes formes and the angles created and these can be measured and described.

Australian Curriculum Subject outcome codes and indicators. Mathematics outcomes above. Media Arts offers an exciting way to build narratives about the properties of quadrilaterals. All the media outcomes can be used in the task described (ACAMAM054, ACAMAM055, ACAMAM056). To meet the Responding Media Outcomes (ACAMAR057) students can analyse existing youtube animations https://www.youtube.com/watch?v=MdSXo0a20iU; https://www.youtube.com/watch?v=Rpkjb4Tx844

THE LEARNING TASK – Media – Year Seven – problem solving and quadrilaterals.
Animation task based on either: drawing a quadrilaterals (linear); construction a 3-D quadrilateral then creating a stop motion story exploring rotation. The key idea is that to create these animations they must apply the mathematical rules of quadrilaterals. An extension could be a story of a kite or any other quadrilateral object. The message must contain the mathematical rules. John wins the kite flying competition because he measured it well.

Including ATSI perspectives: This lesson is well designed to support ATSI learners. Once the learning tool is made, the students are able to deconstruct and reconstruct or they are able to follow if the teacher models the problem solving strategies. The important aspect of the problem solving is that explicit links are made between the clues given and the strategies that solve the problem. Starting with the concrete model and manipulating it to form the various quadrilaterals allows the relationships between them to become apparent.

Strategies to include learners with oral backgrounds: The discussion of the problem, the problem solving strategies and the concrete construction of the learning tool may be advantageous for these students depending on their level of proficiency in English. The manipulation of the learning tool to make and examine the differences in the various types of quadrilaterals allows for repetition of new language that accompanies the different shapes made and facilitates the conceptual similarities and differences. It also allows for the making and remaking of the shapes in the concrete manipulation. Recoding of the observations may be problematic depending on the students' thorough understanding of the use of mathematical symbolic notation. In making the measurement & rules are observable.

Authentic Assessment strategies All outcomes and elaborations can be assessed. The maths understandings can be assessed by: observation, sustained academic conversation or product analysis. The Media Arts outcomes and elaborations can be assessed through observation, documentation as digital image or drawing, talking about stories that illustrate the key ideas, effectiveness in communicating the key ideas to audience.

Variations for students from diverse social contexts: The usefulness of the tasks and their relevance and relationships may heavily depend on students' interests and understand of design and mathematics and the symbolic nature of patterning and relationships of shape. Students from traditional backgrounds often have a wider appreciation of the symbolic nature of shape and the ways it is positioned in their attempts to making meaning and consequently may have a more perceptive approach to this learning if it connects the land and to cultural artefacts. The symbolic representation using the conventional notations may need to be explained carefully in less technical language to maximise student understanding and inclusion.

- The finer the long strips of paper/cardboard the better as the triangles can be more readily manipulated
- Investigate the different triangles by describing their angles

Students develop their knowledge of how ideas and intentions are communicated in and through Media Arts. They build on and refine their knowledge, understanding and skills through Media Arts practices focusing on:

_technologies edit and produce images, sounds and text or a combination of these with selected media technologies **_audience** identifying the variety of audiences and purposes for which media artworks are made **_institutions: individuals, communities and organizations** identifying purpose and processes for producing media artworks and considering individual ethical behaviour and the role of communities and organizations in regulating access to media artworks.

Media—Year 7 Animate Your Quadrilateral

Resources: 5–6 long, narrow paper/thin cardboard strips per student (about 7–8 mm wide) paper or books for recording.

Task: Construct a moveable quadrilateral making sure it meets the following criteria:

- No additional materials are to be used (no sticky tape, fasteners, paper clips, etc.) only the five strips of paper/thin cardboard
- The triangle must be able to be picked up and moved without falling apart—the construction must be robust
- The sides of the triangle must all be able to move independently to show each different type of triangle and hold that shape independently

Discuss: Questions might include:

- How many sides has a quadrilateral?
- How many strips of paper/thin cardboard do you have?
- What might you need the fifth strip for?
- What do you not have that you might need?
- Allow students to discuss all the options they can think of to solve the problem of construction to the criteria. The construction details are below so students can be supported if they get into difficulty.
- https://www.mathsisfun.com/quadrilaterals.html

Construction

- Take the fifth strip of paper/thin cardboard and carefully tear a piece off that is long enough to make a generous loop around the other pieces and have enough to overlap at the ends
- Gently tear the loop horizontally for about a centimetre at each end
- Overlap and interlace the torn pieces so that the loop stays closed
- Repeat so there are two loops
- Undo the interlacing of one of the loops, and holding the closed loop with the open end up, thread the paper/thin cardboard of second loop though the first loop and then redo the interlocking
- This looks like the beginning of an old-fashioned paper chain
- Thread through one of the strips reserved for the sides of the quadrilateral and thread another side through the accompanying loop
- Crease into place on the quadrilateral's sides
- Repeat three times more so that all the sides of the quadrilateral are attached but are able to move independently
- Crease and fold the tops of the sides of the quadrilateral so that the 'fasteners' cannot slide off
- The inside of the framework shows the quadrilateral type that you make
- Students may need an additional strip of paper/thin cardboard depending on the original length of the pieces
- The finer the long strips of paper/cardboard the better, as the quadrilaterals can be more readily manipulated
- Manipulate the sides to make all the types of quadrilateral you know. Draw, name and classify using the sides and angles as criteria for identification. Record in your book.

Task 2: Animation task based on either: drawing a quadrilaterals (linear); Construct a 3-D quadrilateral. Create a stop motion story exploring rotation of a kite and the message must contain the mathematical rules. John wins the kite flying competition because he measured it well.

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Music and Numeracy

Jane Law

Introduction

The links between music and mathematics have been of interest since the Pythagoreans, who deliberated over the connections between musical intervals and ratios (Pesic, 2013). Recent research suggests that content and concepts are common across learning areas and making the links for students by teaching them together can be hugely beneficial '…the greatest impact of interdisciplinary learning seems to be in the potential for making connections: across disciplines, between individuals, and with the wider world' (Bazinet & Marshall, 2015). It is the author's opinion that each person has some level of ability to be creative using music to express themselves. Research for many decades has supported the importance of music education in encouraging creative expression. Panther and Aston (1970: 9) articulate this belief:

> we must also cultivate the artist with ourselves, for each one of us has something of that child-like innocence which is the characteristic of the artistic mind, which draws fresh inspiration from familiar things and expresses feelings in words, actions, visual symbols or music.

This chapter aims to support teachers engaging with their students in quality, classroom activities which enable concurrent development of musical and mathematical concepts. In order to facilitate this aim the chapter presents: (i) a specific definition of classroom music, (ii) research-based evidence of children's innate capacities for identifying with music and building competencies in transference of learning from short term to long term memories (iii) notions of musical pedagogy

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(iv) the integration of numeracy and music and (v) a discussion regarding the development of numeracy skills through engagement with classroom musical activities.

What is Classroom Music?

There are a number of definitions to consider in terms of music teaching and learning in schools. The Australian Curriculum: The Arts, defines the musical roles that students will occupy when they learn music in the primary classroom.

> Making in Music involves listening, imitating, improvising, composing, arranging, conducting, singing, playing, comparing and contrasting, refining, interpreting, notating, practising, rehearsing, presenting and performing. Responding in Music involves students being audience members listening to, enjoying, reflecting, analysing, appreciating and evaluating their own and others' musical works. (The Revised Draft Australian Curriculum: The Arts Foundation to Year 10, 2013: 93.)

For the purposes of this chapter, *classroom music* is defined by the author as the process whereby a class of students is introduced to the concepts of music (rhythm; pitch; dynamics and expression; form and structure; timbre and texture) through a variety of learning activities that involve listening, singing, playing, moving and organising sound. This definition of classroom music does not include additional (or co-curricular) musical activities that occur in primary and secondary schools such as choirs, instrumental ensembles and musical theatre.

Concepts of Music—Australian Curriculum Assessment and Reporting Authority (2013: 136–140)
Rhythm: (including tempo and metre): the organisation of sound and silence using beat, rhythm and tempo (time)
Pitch: the relative highness or lowness of sound. Pitch occurs horizontally (as in a melody) and vertically (as in harmony)
Dynamics and expression: the relative volume (loudness) and intensity of sound and the way that sound is articulated and interpreted
Form and structure: the plan or design of a piece of music described by identifying what is the same and what is different and the ordering of ideas in the piece
Timbre: the particular tone, colour or quality that distinguishes a sound or combinations of sounds

Teaching music in the primary classroom is not about detailed instruction in the skills necessary to play an orchestral instrument to a high level, nor is it about discovering, amongst a class of students, musical prodigies to be then nurtured and developed. It is about enabling **all** students to be creative, using music to express themselves and in this case, improving their numeracy capabilities at the same time.

Research-Based Evidence Regarding Music and the Brain

The benefits for students that result from engaging in musical processes and skills have been well documented. Jeanneret (2013), summarised and compiled these findings for the Victorian Parliament's inquiry into the extent, benefits and potential of music education. Amongst the findings she identified were the following. They were sourced from various disciplines including education, psychology, music and neuroscience and are particularly relevant for this context.

- A larger corpus collosum, which allows for a high number and faster synapses (messages) to travel from one side of the brain to the other (Peretz & Zatorre, 2005).
- A larger motor cortex where planning and voluntary motor functions are controlled (Peretz & Zatorre, 2005).
- More highly developed neurofilaments which leads to faster and more synchronised neural firings (Hannon & Trainor, 2007).
- A denser auditory cortex (Janata et al., 2002) and grey matter (Gaser & Schlaug, 2003), and thus respond to auditory stimuli more effectively and have the capacity to store more information.
- Significantly higher abilities in memory, including short and long term memory retention and retrieval (Dunbar, 2009; Jonides, 2008).
- A more highly developed executive function which is the ability to regulate our cognitive and emotional responses (Bialystok & DePape, 2009; Posner, 2008).
- More developed geometrical skills (Hannon & Trainor, 2007).
- More highly developed neural pathways (Ball, 2008; Trainor, 2008; Wills, 2007).

Research carried out at Melbourne University also focusses on the effects of musical activity on brain activity and development:

> There are now over 100 neuroimaging studies showing that music activates multiple brain networks during music listening, responding and performance. As a result, when we compare musicians and non-musicians there are substantial differences in size, shape, density, connectivity, and functional activity that occur extensively throughout the musician's brain… The brain can change in response to music and [there is a] broad range of cognitive processes and behaviors this may impact. Powerful amongst these is the ability of music to prime the brain for future learning, whilst more broadly promoting our individual and social wellbeing. (Wilson, 2013: 1)

Music activities can also contain the following ideas and tasks.

- Rhythm activities that provide opportunities to explore pattern, develop algebraic expression and explore equations in addition.
- Musical activities that have the potential to support learning in basic mathematical memory activities such as number facts, timetables and other mathematical skills related to repeat rehearsal for instant recall.
- Interactions with a form of written music called graphic notation which present occasions during which spatial and geometric concepts can be strengthened.
- Opportunities for students to use musical structures in order to create their own compositions can link with a range of mathematical concepts, e.g. lapsed time, pattern in numbers or even fractions.

Notions of Musical Pedagogy

There are a number of theoretical approaches to teaching music in the primary classroom, however a classroom teacher with a love of music, but not necessarily years of formal music training, needs to find an approach that is flexible and able to be integrated with other curriculum areas.

Foremost among the approaches suitable for a primary classroom, that focus on active music making and high student engagement are as follows:

- The Orff (Schulwerk) Approach
- The Kodaly Method
- The Dalcroze Method.

In this chapter, it is suggested that the pedagogical approach which is most valuable for general primary teachers aiming to integrate numeracy and music is the Orff–Schulwerk approach. The Orff approach is the most promising for teachers who are seeking ways of integrating instruction because as the name suggests, the

Orff approach is not a methodology or a lineal, sequential series of lessons, concepts or graded steps. It is not a method with a predetermined progression of ideas.

Orff–Schulwerk activities present prospects of appropriate development of ideas, of experimentation, of improvisation and innovation without the rigidity of the learning sequences found in other, more formal approaches. For example this approach has, as one of its central platforms, the concept of rhythm. Rhythm in movement, speech and music.

> This approach is activity based. Students learn music by actually doing it. They are engaged in the learning process by experiencing, experimenting, creating, improvising and participating in different musical activities. It is this approach that can facilitate problem solving skills and strategies while nurturing creativity and self-expression. Creating and improvisation is embedded in the Orff approach and these types of activities require students to think divergently. Divergent and creative tasks are known to require certain areas of the brain to coordinate the thinking. These are areas that do not work together during the completion of convergent tasks. Creativity is often thought of, incorrectly, as a special quality that individual innately possess, not as a competency that can be developed (Hardiman, 2010b).

Improvisation has also been shown to contribute positively to the brain's creative capacity. Deasy (in Hardiman, 2010b: 233) identified some positive learning behaviours that could be fostered by students engaging in the arts. These included:

- Persistence in sustaining concentrated attention to a task
- Symbolic understanding by using multiple modes to communicate
- Resilience in overcoming frustration and failure
- Engaged learning through absorption in content
- Collaborative learning as a member of group processes for acquiring and manifesting knowledge.

- The brain is 'wired' to seek out patterns and relationships (Hardiman, 2010a), both of which are vital to understanding mathematical foundations and musical composition.
- The positive learning behaviours that are associated with students engaging in the arts are able to impact positively in other areas of curriculum, including numeracy.

Interdisciplinary Learning—Numeracy and Music

Integration of music and numeracy (or mathematics) lessons into one process makes perfect sense, especially in the Orff–Schulwerk approach to music education. However, whichever music/numeracy approach or approaches teachers use in their classroom must be underpinned by sound mathematical understandings embedded as numeracy capacities. This does not imply that students must first have formal mathematical knowledge in order to create music, in fact it may be quite the reverse. Some important findings on the links between classroom music and numeracy are found in research about the arts. The significant 'Champions of Change—The Impact of the Arts on Learning' (Fiske, 1999) was carried out at Columbia University and published in 1999. This seminal research focussed, in part, on the links between rich in-school arts learning and academic success. A diverse methodology was used combining standardised tests, paper and pencil inventories, a self-description questionnaire and a teacher perception scale. Over two thousand children in public schools in New York, Connecticut, Virginia and South Carolina were involved in this study.

This research, although encompassing all the arts, points to the particular importance of music in four of the seven sections of the report. Many aspects of music in schools including curriculum implications were highlighted. The results of the study revealed that the children who had received 'high exposure to an arts rich curriculum' scored significantly higher in:

- creative thinking abilities of fluency, originality, elaboration and resistance to closure
- general capabilities such as expression, risk taking and imagination
- perceptions of themselves as mathematics learners (Fiske, 1999: 54–55).

Growing interest in the links between numeracy (mathematics) and music has led to recent exploratory research which investigated the way teachers have integrated music and mathematics. (Song, Capraro, & Tilman, 2013) indicated that integrating music/mathematics lessons had a positive effect. Forty-six students from grade 1 and grade 3 participated in music composition and playing activities while investigating mathematics learning in such areas as patterning, subtraction, fractions and addition.

After 5 weeks, the study showed:

- Music can connect to mathematics in a range of content areas.
- Students demonstrated statistically significant improvements in almost all assessments of mathematical ability.
- The lessons facilitated students engagement and motivation (Song et al., 2013: 14–15).

Conclusion

These studies indicate the positive impact of integration of music and mathematics. This integration impacts both student's perceptions of mathematics and their perceptions of themselves as learners of mathematics. However, it also the increase in the creative thinking, expression, imagination and risk taking that could be the most significant for the future of these students and their children (Bazinet & Marshall, 2015; Fiske, 1999; Hardiman, 2010b; Song et al., 2013).

- Numeracy competencies are found in music, irrespective of the pedagogical approach implemented
- Tasks that combine numeracy competencies and music can be progressively developed to involve a range of symbolic representation and mathematical competencies in number, space, pattern and algebra.

Differentiation

The task can be differentiated when students make their own rhythm pattern for a number under 10. Students can then make rhythms for larger numbers.

Australian Curriculum Mathematics Outcomes

ACMNA002
Connect number names, numerals and quantities, including zero, initially up to 10 and then beyond.

Numeracy Links

Understanding that the arrangement of objects does not affect how many there are.

Australian Curriculum Music Outcomes

Develop aural skills by exploring and imitating sounds, pitch and rhythm patterns using voice, movement and body percussion (ACAMUM080)

The Learning Task - Foundation

Students echo rhythm patterns and devise their own body percussion rhythm patterns.

Students find collections of familiar objects to establish an understanding of numbers to 20.

Students imitate rhythm patterns in order to represent the number 4 and other larger numbers to 20.

Including ATSI perspectives

All students can work non-verbally in the activity based hand-on tasks. The class can utilize objects from their tribal culture to form collections of objects for use with the entire class. The inclusion of ATSI parents or teaching assistants would be advantageous.

Strategies to include learners with oral backgrounds

This task uses rhythm to enable students to understand the concept of numbers. It supports students of oral backgrounds by using exclusively pictures and rhythm. The teacher would not be giving written or even verbal 'instructions' but using gestures and sound to teach the number concept.

Authentic Assessment strategies

Observing students as they actively engage with the lesson will enable targeted product analysis. Recording students as they demonstrate their rhythm patterns can be invaluable as a tool to communicate with parents.

The recordings are evidence of student attainment and can contribute to digital portfolios for each student.

Variations for students from diverse social contexts

Students can illustrate their chosen number by collecting objects representative of their culture. Students can be encouraged to bring items from home and these objects can be used when repeating the lesson to encompass larger and more complex numbers.

Foundation

Music/numeracy lesson	Resources
The aim of this lesson is for students to imitate, count and devise 'body percussion' rhythm patterns Students devise their own body percussion patterns for even numbers under 10	HINT Body Percussion consists of clapping, clicking, hitting thighs (called patchen) and stamping
1. Teacher claps 4 times—students copy 2. Teacher—How many claps? 3. Teacher stamps twice then claps twice—students copy 4. How many stamps and how many claps? Students count as teacher repeats two stamps and then two claps* 5. How many sounds did we make altogether? 6. Teacher claps 6 times—students copy 7. Teacher—How many claps?* 8. Teacher stamps 6 times—students copy 9. Teacher—How many stamps?* 10. Teacher claps 3 times and stamps 3 times—students copy 11. How many claps and how many stamps? Students count as teacher repeats three stamps and then three claps 12. Students choose number 2, 4, 6 or 8 and make their number by clapping and stamping** 13. Students demonstrate their numbers. Each group demonstrate their combinations**	For each body percussion rhythm, students count the number of claps, stamps and shoulder pats HINT Teacher may also demonstrate using percussion instruments, e.g. woodblock hit three times then a drum three times HINT Let the students choose their own number. This is a good differentiation strategy

Differentiation

The task can be differentiated by students selecting their own addition sentences, at appropriate levels, to represent with body percussion sounds.

Australian Curriculum Mathematics Outcomes

Represent and solve simple addition problems using a range of strategies including on, partitioning and rearranging parts - ACMNA015

Numeracy Links

Develop a range of mental strategies for addition problems.

Australian Curriculum Music outcomes

Develop aural skills by exploring and imitating sounds, pitch and rhythm patterns using voice, movement and body percussion (ACAMUM080)

Imitating pitch and rhythm patterns to develop aural recognition skills, for example, echo clapping.

The Learning Task – Year One

Students echo body percussion patterns and create their own patterns to solve simple addition problems.

Students analyse sound patterns, write and record addition sentences.

Including ATSI Perspectives

Focus on where the students would need to use these number sentences in the world outside the classroom, be sensitive to the code changing from traditional numeracy to western, abstract, symbolic representation. Engage though narrative and story- telling. Use traditional ATSI clapping sticks to perform the rhythms instead of using body percussion.

Strategies to include learners with oral backgrounds

This task uses rhythm to enable students to understand the concept of numbers.

Using flash card to write number sentences should be approached when students have had extended experience with rhythmic representation of addition if accompanied by lots of repetition, action, performance and responses to link the written with the activity, then with the symbolic representation of number and the symbolic representation of action (+, - , =)

Authentic Assessment strategies

Recordings of students performing rhythm patterns provide assessment data for both Mathematics and Music.

The number sentence flash cards provide a worksample that can form the basis of teachers' anecdotal records.

Variations for students from diverse social contexts

Picture books can be used to introduce this lesson to reflect students' social contexts.

Year 1

Music/numeracy lesson	Resources
The aims of this lesson are for students to • Echo body percussion patterns • Create their own body percussion patterns • Write sound patterns using number algorithms	Body Percussion consists of clapping, clicking, hitting thighs (called patchen) and stamping
1. Teacher (Clap, patchen, patchen, clap) 2. Students echo the body percussion (BP) pattern 3. Students and teacher count the sounds while performing the BP pattern again 4. Teacher/students analyse the pattern of sounds performed by the teacher. How many of each type of sound? How many sounds altogether? (2 claps plus 2 patchen are 4 sounds altogether)* 5. Teacher (Clap, clap, stamp, stamp) 6. Students echo 7. Students and teacher count the sounds while performing the BP pattern again* 8. Teacher/students analyse the BP pattern performed by the teacher. How many of each type of sound? How many sounds altogether? (2 claps plus 2 stamps are 4 sounds altogether)* 9. Repeat with other numbers to 10 10. In pairs students choose a number and make up a BP pattern. How many BP patterns can they devise for their number? 11. Each group chooses a BP pattern to demonstrate to the class. How can we write this BP pattern down with numbers?* 12. Flash cards can be used to record addition sentences	HINT Some students cannot click their fingers. Students can pretend by making an approximation of the movement. In some circumstances, it may be appropriate to substitute another sound (e.g. shoulder tap) HINT Students will benefit from many repetitions of step 4

Differentiation

Introducing the concepts of dynamics and speed to step 6 enables the leader to vary the music he/she is creating a sound scape.

A greater number of shapes used in the art work challenges more able students.

The level of complexity can also be increased by using irregular shapes.

Australian Curriculum Mathematics Outcomes

Describe and draw two-dimensional shapes, with and without digital technologies - ACMMG042

Numeracy Links

Identifying key features of squares, rectangles, triangles, kites, rhombuses and circles, such as straight lines or curved lines, and counting the edges and corners.

Australian Curriculum Subject outcomes

Create compositions and perform music to communicate ideas to an audience (ACAMUM082)
Choosing and combining sounds to create compositions.

The Learning task – Year Two

Students use 2D shapes as graphic notation to construct a sound scape.

Students draw representations of regular and irregular two-dimensional shapes to form an art work.

Students assign each shape a sound that relates to a characteristic.

A student leader constructs a composition using the shapes.

Including ATSI perspectives

Traditional ATSI symbols can be used by the class to construct the art work in a subsequent lesson. Differences between shapes in the first lesson and shapes in the second lesson can be discussed. However, as most traditional art does not involve angles, as it may be that the students actually find the default position themselves.

Strategies to include learners with oral backgrounds

This task uses graphic notation to link a two-dimensional shape to an appropriate musical sound.

The pedagogical strategies are based around oral discussions, music and visual arts. These pedagogies are highly appropriate for students with oral backgrounds, most especially in actions, repetitions, narrative and response to suggested actions and directions

Authentic Assessment strategies

Sustained Academic Dialogue (SAD) conferences with students either individually or in groups can focus on:

- The qualities of the sounds chosen
- The characteristics of the shapes chosen when constructing art work.

Variations for students from diverse social contexts

Students from diverse social contexts will bring a rich background of experiences that will enable creative selection of symbols and shapes.

The student led pedagogical approach is demonstrably effective in engaging students with behavioural challenges, diverse learning needs, different social experiences, interests and creative capacities

Year Two

Music/numeracy lesson	Resources
Graphic notation Graphic notation is the representation of music using visual symbols. The symbols can represent any of the music concepts (Pitch, Tone Colour, Dynamics, Rhythm, Structure). Graphic notation scores can be very simple (as in the lesson below) graduating to more and more complex as students develop their understanding of musical notation and composition The aims of this lesson are for students to • Experiment with 2D shapes to construct a visual pattern* • Experiment with a range of environmental sounds in the classroom and/or playground • Use the 2D shapes as graphic notation to construct a sound pattern*	
1. Draw three different 2D shapes on the board so that they take up much of the space and intersect in different ways, e.g. 2. Divide the class of students so that each group ‘owns’ a particular shape 3. Each group explores their classroom environment to find a sound they like and can all play together, e.g. ruler slapping the desk, metal chair legs hit by a pencil, paper being scrunched 4. The teacher (or a student) takes a metre ruler and drags it across the board crossing over the shapes 5. Whenever the leader’s pointer crosses the shape’s perimeter the groups make their sound 6. The leader can vary the speed, stop and even travel along the perimeter lines (so that a continuous sound is made) 7. Students (individually or in groups) create their own piece of music by drawing shapes on art paper and deciding what sounds are assigned to each shape. The sounds can represent a place or story, e.g. a storm at sea or a school athletics carnival	Representations of regular and irregular two-dimensional shapes and their names around the classroom. Drawing implements, paper Whiteboard or electronic Smart Board HINT This activity can also be done effectively on a blackboard, whiteboard or with butchers’ paper NOTE The concept of perimeter is not taught in this lesson HINT In step 2: Group 1—Oval Group 2—Quadrilateral Group 3—Pentagon Metre ruler or another suitable pointer Art paper and drawing implements

Differentiation

The introduction can be differentiated in many ways by accessing a variety of backing tracks from you tube. The examples given are based around the musical genre of 'blues', however other genres are available to be used. Multiplication algorithms can be increased in difficulty and other symbols e.g. (represented by hands).

Australian Curriculum Mathematics Outcomes

Explore and describe number patterns resulting from performing multiplication ACMNA081

Numeracy Links

Identifying examples of number patterns

Australian Curriculum Music Outcomes

Develop aural skills by exploring, imitating and recognising elements of music including dynamics, pitch and rhythm patterns (ACAMUM084)

Singing learnt pitch and rhythm patterns and varying elements of music within them to create different effects, for example, singing faster or slower, repeating phrases.

The Learning Task – Year Three

Students link multiplication to rhythm patterns and use a stamp to indicate the process of multiplication.

Body Percussion is used as a tool for expressing the concept of multiplication.

Body Percussion consists of clapping, clicking, hitting thighs (called patchen) and stamping.

Including ATSI perspectives

This lesson is very appropriate for ATSI students as traditional aboriginal singing is often accompanied by hand clapping or thigh clapping and buttocks-slapping. The class can acknowledge these actions as part of various cultural heritages

Further information can be retrieved from: http://aboriginalart.com.au/didgeridoo/instruments.html

Strategies to include learners with oral backgrounds

The emphasis in this lesson on performing a wide variety of rhythms will boost student involvement and interest.

Additional scaffolding should be provided to enable students to devise a method of writing /recording their multiplication patterns. These may be drawings or simple symbols. Movement, repetition and chanting are also part of the highly developed cognitive learning strategies for students with oracy backgrounds

Authentic Assessment Strategies

After selecting a multiplication algorithm from those displayed around the classroom, each student explores a variety of rhythmic body percussion patterns that illustrate the algorithm. Students can demonstrate the rhythmic pattern to the teacher or submit the assessment in writing by devising a method of writing down their rhythmic pattern.

Variations for students from diverse social contexts

Students bring a rich variety of rhythmic backgrounds to this lesson. Body percussion is a folk tradition of countries that include Ethiopia (armpit music) and Spain (flamenco).

Explore the cultural backgrounds of students in this area and involve community members to perform rhythms that reflect their social and cultural backgrounds. Special needs students may need support.

Year Three

Music/numeracy lesson	Resources
The emphasis in this lesson is for the students to keep a regular beat while imitating teacher devised body percussion patterns Students also devise their own body percussions to accompany a backing track (see suggested backing tracks) In step 5, the sound of a stamp is used as a multiplier and students answer by clapping the correct number	
1. Listen to the backing track, clap the beat 2. Teacher performs simple Body Percussion patterns for the students to copy, e.g. clap, clap, clap, click 3. Perform the Body Percussion patterns to the backing track 4. Student volunteers make up short patterns to the backing track and teach the other students, e.g. patchen, patchen, clap 5. Teacher introduce the concept that a stamp means to multiply* 6. Teacher—four claps, stamp, two claps* 7. Students clap back the answer (8)* 8 Teacher—three claps, stamp, five clicks* 9. Students clap back the answer (15)* 10. Once the students understand the concept this activity can be done to a backing track 11. Choose 4 students to lead. Each student takes it in turn to 'ask the number question'* 12. Each of the 4 student leaders asks the number question then the rest of the class claps the answer back* 13. The student leaders can point to the group that is to answer the question	https://www.youtube.com/watch?v=9H2oY_85q8U https://www.youtube.com/watch?v=y1ueWz4-Hkk https://www.youtube.com/watch?v=hZWNb5AZDWk https://www.youtube.com/watch?v=Dxo2bEX45KI HINT Before choosing the students to lead, ask all the students in the class to make up 2 of their own body percussion patterns HINT Insist that the students make up very simple body percussion patterns. This activity does not work if complex patterns are tried before the concepts are understood

Differentiation

The song 'One Bottle of Pop' is made up of 3 different sections. Each section can be taught separately with appropriate rhythmical activities for each section.

Improvising a harmony part to fit with any of the three sections of this song encourages less adherence to the melody and more creativity when singing.

Australian Curriculum Mathematics Outcomes

Investigate number sequences involving multiples of 3, 4, 6, 7, 8, and 9 ACMNA074

Numeracy Links

Recognising that number sequences can be extended indefinitely

Australian Curriculum Music Outcomes

Practise singing, playing instruments and improvising music, using elements of music including rhythm, pitch, dynamics and form in a range of pieces, including in music from the local community (ACAMUM085)

Rehearsing and performing music in unison and with accompaniment patterns.

The Learning Task – Year 4

Students learn and sing the song "One Bottle of Pop." They discuss the number of beats in each bar of the song and investigate some possible number sequences e.g. starting on 3 and increasing by 3's.

Another version of the song: https://www.youtube.com/watch?v=_je-rbBgOLo

ATSI considerations

All students can develop lyrics that reflect this cultural group. A list of names of items in appropriate ATSI language can be used to construct the song e.g. 'One loaf of nulai (bread in Awabakal), two loaves of nulai, three loaves of nulai, four loaves of nulai.

Source: http://www.miromaa.org.au/shop/products/language-resources/item/awabakal-bushtucker-poster.html?category_id=4

Strategies to include learners with oral backgrounds

Construct different lyrics for the same tune – especially effective if the class has just been on an excursion or has enjoyed a popular whole school event such as a sports carnival or students have come to the class from various backgrounds and experiences – singing is culturally inclusive and can be part of language development and memorising for students with oracy backgrounds. Any words in multipole languages can be sung in the lyric variation

Authentic Assessment Strategies

Record students singing – as a class and/or in groups.

Students use the audio-visual recordings to evaluate their performance. The criteria used to evaluate the performance should be jointly constructed and agreed by the class.

Variations for students from diverse social contexts

The involvement of parents as partners in this lesson enables them observe their children being successful. Students who have behavioural challenges can often respond to:

- Being selected as a leader (ensure that the student is successful here!)
- Being selected to provide the stamps (it will also appeal to kinaesthetic learners.)

Engaging with lyrics that reflect their own understanding and language use, code or register- allows students to create meaning

Year Four

Music/numeracy lesson	Resources
In this lesson students practise singing, using elements of music–rhythm and pitch. They investigate number sequences involving multiples of 3 and recognise that multiples of 3 can start from any number	
1. Learn the song ‘One Bottle of Pop’ 2. This song can also be sung as a round where the class is divided into three sections and each begin after the words—‘Seven bottles of pop!’ 3. Number the beats in the song ‘One Bottle of Pop’ as follows: 1 2 3 One Bottle of Pop 4 5 6 Two Bottles of Pop 7 8 9 Three Bottles of Pop 10 11 12 Four Bottles of Pop 13 14 15 Five Bottles of Pop 16 17 18 Six Bottles of Pop 19 20 21 22 Seven Bottles of Pop 4. Investigate the number sequence starting on 3 and increasing by 3. Put a red circle around all the numbers in this sequence (3, 6, 9, etc.)* 5. Students sing the song and clap on the numbers with red circles* 6. Investigate the number sequence starting on 1 and increasing by 3 by put a green circle around this number sequence (1, 4, 7, etc.)* 7. Students sing the song and stamp on the numbers with green circles* 8. Half the class sings and the other half claps on the number sequence increasing by 3, starting on 3 (red)* 9. The other half of the class sing, accompanied by the rest of the students stamping on the number sequence increasing by 3 starting on 1 (green)*	https://www.youtube.com/watch?v=u-TdsmPHjo0 HINT The song ‘One Bottle of Pop’ is in groups of 3. Songs in groups of 4 can also be used: • Miss Mary Mac • Old Macdonald • Ging Gang Gooli • Boom Chicka Boom • Agadoo All these songs are available to download on YouTube but be careful of the advertisements if you are using YouTube to teach the songs to your students HINT This activity can form the basis of a great assembly item

The Learning task – Year Five Multiples

In this lesson students improvise and experiment with combinations of non-tuned percussion sounds to create and accompaniment to a number chant.

Students revise multiples of 8 then generate number patterns. These number patterns are turned into musical compositions by assigning sounds to each digit from 0 to 9.

Differentiation

The number pattern used in this lesson was based on the multiples of 8. The lesson can be differentiated by using easier or more difficult number patterns. A range of musical sounds can be utilized. Sources of sounds can range from environmental sounds (classroom taps hit with rulers); tuned percussion (xylophones or metalaphones); or unusual voiced sounds.

Australian Curriculum Mathematics Outcomes
Describe, continue and create patterns with fractions, decimals and whole numbers resulting from addition and subtraction. ACMNA107

Numeracy Links
Using diagrams to create patterns involving

Australian Curriculum Music Outcomes
Rehearse and perform music including music they have composed by improvising, sourcing and arranging ideas and making decisions to engage an audience. (ACAMUM090)

Improvising and experimenting with combinations of sounds and technologies to create moods and atmospheres.

Including ATSI perspectives

Traditional ATSI musical instruments (or replicas) can be used by the class to make the sounds for each digit from 0 to 9.

Students can use these when constructing their own music:

- Clapsticks, Boomerang Clapsticks, Percussion Tube, Rasp, Rattle, Bullroarer.

Strategies to include learners with oral backgrounds

This task uses different sounds to enable students to understand the concept of multiples of a number. It reinforces that numbers are patterns that can be played with and manipulated. This can be enhanced by movement, chanting repetition of patterns and visual representations of numbers that are not Hindu- Arabic mathematical symbols

Authentic Assessment Strategies

Each student group perform their multiples music for the class.
As the teacher is recording anecdotal records of the performance, the rest of the class complete a feedback sheet where they identify:

- The multiple used
- The next three multiples
- Their favourite sounds etc....

Variations for students from diverse social contexts

Explore the un-tuned percussion instruments used in a variety of diverse cultural backgrounds e.g. Indonesia, Sudan, Egypt and China and the simpler instruments that were traditionally used by Australian settlers. What are the bottle top sticks called, also the bodhran, spoons, gum leaves, other types of drums as these are very basic and made from literally anything – bucket bands, steel bands, bush bands etc

Year Five

Music/numeracy lesson	Resources
In this lesson students improvise and experiment with combinations of non-tuned percussion sounds to create and accompaniment to a number chant	
1. Generate a number pattern chant using the multiples of 8 starting from 8 to 8, 16, 24, 32, 40, 48 56 64 72 80, 88, 96* 2. Assign a non-tuned percussion sound to each digit from 0 to 9 e.g. 0 = Tambourine 1 = Bells 2 = Triangle 3 = Large Drum 4 = Small Drum 5 = Sticks 6 = Guiro 7 = Castanets 8 = Cabasa 9 = Cow Bell 3. Give the above non-tuned percussion instruments to students 4. Teacher chants the multiples of 8 while the relevant percussion instruments 'play', the numbers* 5. Teacher (or student) chants the multiples of 8 again with a backing track while the percussion instruments are played* 6. Students form friendship groups, select another number and find multiples of another number, (this step can be differentiated to suit the ability of the students), and form their own musical composition Students discuss timbre of different non-tuned percussion instruments to help inform their instrument selection 7. Students can find a rhythmic backing track on YouTube (see link)	HINT After the first section of the lesson and brief demonstration of the concepts, this lesson is constructed to enable student exploration The role of the teacher is to encourage and enable not direct Students explore the relevant multiple pattern display the patterns using musical sounds HINT Displaying the number patterns on a blackboard or whiteboard gives students who are less confident the ability to fully participate HINT Students swap percussion instruments then repeat step 5. This can be done a number of times to really ensure a depth of understanding https://www.youtube.com/watch?v=22mWUkAi0PI https://www.youtube.com/watch?v=HiWhPNtDuQ0

Differentiation

Sound sources used in this lesson should be differentiated and enable students to choose from: voiced sounds (e.g. beat box), environmental sounds (classroom taps hit with rulers), non-tuned percussion sounds and body percussion sounds.

Australian Curriculum Mathematics Outcomes
Identify and describe properties of prime, composite, square and triangular numbers ACMNA122

Pedagogical Strategies
Understanding that some numbers have special properties

Australian Curriculum Music Outcomes
Rehearse and perform music including music they have composed by improvising, sourcing and arranging ideas and making decisions to engage an audience. (ACAMUM090)

Improvising and experimenting with combinations of sounds and technologies to create moods and atmospheres.

The Learning Task – Year Six

Improvisation and experimentation is enabled by the utilization of prime and composite numbers to form a musical structure.

Student friendship groups construct a musical composition based on prime and composite numbers.

Students dissect the musical composition and discuss the prime and composite numbers represented.

Including ATSI perspectives
Traditional ATSI musical instruments – or replicas can be used by the class when playing their prime or composite numbers:

- Clapsticks, Boomerang Clapsticks, Percussion Tube, Rasp, Rattle, Bullroarer.
- Folded leaf whistle, hollow log struck with a small stick, Didgeridoo (traditionally only played by men in very few indigenous groups in Australia)

Strategies to include learners with oral backgrounds
As the students make musical representations of number patterns they are exploring their personal meanings and understandings of mathematics concepts. It is valuable, as a concluding activity, for these and all the other students in the class to talk about the decisions that were made in the construction of the music and the reasons why those decisions were made and to record these in ways that are personally meaningful.

Authentic Assessment Strategies

Sustained Academic Dialogue (SAD) conferences with students either individually or in groups can focus on:

- Students definitions of prime and composite numbers
- The musical timbre of the sounds chosen in their musical compositions.
- Classifying numbers as prime or composite.

Variations for students from diverse social contexts.

Music can be a motivator for all students including those with special needs. Music is also part of all cultures and social classes. It enables many of them to participate in a whole class lesson. Students who need additional support to fully participate can select instruments that allow them to produce a sound. All students can use their own music preferences and socially diverse musical knowledge to enable their creativity.

Year Six

Skeleton music/numeracy lessons	Resources
This lesson uses prime and composite numbers to construct a rhythmic composition. Prime and composite numbers form a structure to enable a musical composition to be created where every student contributes	A class composition is constructed in this lesson where each group of students is responsible for one part of the musical composition This lesson can be repeated so that the teacher is a mentor or guide and the students explore other number patterns
1. Divide the students into six groups and ask each group to make up one sound that they will all perform together. To ensure variation in the sounds, teachers may assign each group a different type of sound e.g. a. Tuned Percussion b. Non-tuned Percussion c. Environmental Sounds d. Metal sounds e. Body Percussion Sounds f. Vocal Sounds 2. Explore the composite and prime numbers to 100 by assigning the numbers as follows a. Group 1—Prime Numbers to 100 b. Group 2—Composite numbers with a factor of 4–100 c. Group 3—Composite numbers with a factor of 3–100 d. Group 4—Composite numbers with a factor of 7–100 e. Group 5—Composite numbers with a factor of 9–100 f. Group 6—Composite numbers with a factor of 8–100 3. Each group explores the type of sound that they could play 4. Each group makes their sound on ONLY their assigned numbers* 5. The teacher count from 1 to 20 and groups has make their sound on their assigned numbers* 6. The teacher (or student leader) establishes a beat by clicking fingers and counts from one to 30 while other students perform* 7. Teacher or student leader establishes the beat but does not count out loud. Students listen to the combination of sounds and rhythms as they play* 8. Class discussion: a. How can this class composition be improved? b. Can dynamics be added? c. Does any group wish to change their sound? 9. The class composition can be performed any number of times and then recorded	Whiteboard or electronic Smart Board Tablets, Computers or paper Non tuned percussion instruments (if appropriate) HINT Voiced sounds can be any type of sounds that you can make with the voice or throat. See link—https://www.youtube.com/watch?v=CPKq9sDIs2M HINT This activity can be concluded with a reflective activity where the students reflect on the musical composition produced

Differentiation

Development of a variety of musical sounds can reflect a specific event or environment e.g. a storm.

Students should attempt to record their music so that others can reproduce it.

Students can choose to investigate any group of prime, composite, square and triangular numbers, even very large numbers e.g. numbers over 10 000.

Australian Curriculum Mathematics Outcomes

Identify and describe properties of prime, composite, square and triangular numbers ACMNA122

Numeracy Links

Understanding that some numbers have special properties

Australian Curriculum Music Outcomes

Develop musical ideas, such as mood, by improvising, combining and manipulating the elements of music (ACAMUM093)

The Learning Task – Year Seven

Students use their understanding of Prime, Composite, Square and Triangular Numbers to construct a musical composition.

Including ATSI perspectives

Relate prime numbers to a real-world situation that illustrates the differences in ways of thinking about numeracy, e.g. having a BBQ where there are 101 people and they have to sit at tables in even groups. What would you do? Allow the students to construct and deconstruct a scenario several times to facilitate learning. Have a 'yarn-up', draw pictures and make a physical model.

Strategies to include learners with oral backgrounds

Give students with oral backgrounds more time to understand requirements of the lesson. This is especially important if the lesson uses a pedagogy which is not teacher directed.

Begin the lesson with a visual activity that involves the targeted concepts e.g. prime, composite, square and triangular numbers.

Authentic Assessment Strategies

Students develop an electronic or paper portfolio that reflects the development of their:

- Understanding of the musical terms
- Exploration of types of sound
- Contribution to the final group

Variations for students from diverse social contexts.

Construct a mind map to introduce the lesson. Give each child a number of sticky notes and ask them to add information about prime, composite, square and triangular numbers to the mind map.

Students can use any information source to help them revisit the concepts. They can also use their different ways of calculation and making meaning that reflects the cultural and social backgrounds.

Music: Year Seven

Music/numeracy lesson	Resources
This lesson uses different types of numbers to form a rhythmic composition. The lesson revises the concepts of Prime, Composite, Square and Triangular Numbers	
1. In friendship groups students explore body percussion, environmental and non-tuned percussion sounds. They list 3 examples of sounds in each category and choose one favourite 2. Each friendship group is given a set of numbers: a. Group 1—Square numbers to 100 b. Group 2—Triangular numbers to 100 c. Group 3—Prime numbers to 100 d. Group 4—Composite numbers with a factor of 7–100 e. Group 5—Composite numbers with a factor of 8–100 f. Group 6—Composite numbers with a factor of 2–100 3. The teacher or student leader establishes a beat by clicking fingers (or playing the beat on a non-tuned percussion instrument) and while counting from one to 20 4. All groups play on their assigned numbers 5. Discussion regarding the patterns discovered. Who plays on 20? Why? Is there a number that all students play on? Why or Why not?* 6. All groups play together while the teacher/student leader counts to 30* 7. All groups play together while the teacher/student leader **beats** to 40 (without saying the number)* 8. Perform this again (to 50) with a backing track*	Whiteboard or electronic smartboard Tablets, Computers or paper Non-tuned percussion instruments (if available) https://www.youtube.com/watch?v=NuqH7_vFNRg https://www.youtube.com/watch?v=NuqH7_vFNRg

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Physical Education and Numeracy

Adam Lloyd, Narelle Eather and Nick Riley

Introduction

In the primary school setting, evidence-based physical education (PE) programs can make substantial and distinctive contributions to a child's development in the physical, affective, social and cognitive domains (IOM (Institute of Medicine), 2013; Jenkinson & Benson, 2010; Morgan & Hansen, 2007). When PE is well planned, adequately resourced and delivered with confidence there are real opportunities to have students engaged in the learning experience. Of note, links can be made to Mathematics, and ultimately real-world applications of numeracy content and concepts can be experienced. Later in this chapter, a brief rational and potential for integrating mathematics into PE will be discussed. Some of the other key benefits of having students participate in PE programs are detailed below.

The Physical Activity Aspect/Opportunity of PE

For many students, their time at school would involve prolonged bouts of sitting (Donnelly & Lambourne, 2011), poorly taught PE, and lessons that involve low levels of activity (Lonsdale et al., 2013). However, emerging research suggests that

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reducing sedentary behaviour may improve the health of children, and that movement aids learning and may actually enhance learning in other curriculum areas (Tomporowski, Davis, Miller, & Naglieri, 2007). Importantly, PE could be considered the central vehicle for promoting physical activity within schools (Eather, Morgan, & Lubans, 2013).

Studies have shown that children who participate in high levels of physical activity, especially vigorous activity, and display high levels of health-related physical fitness benefit both in the short and long term (Caspersen, Powell, & Christenson, 1985; Malina, 1996; Ortega, Ruiz, Castillo, & Sjostrom, 2008). Active and fit children display fewer markers for Metabolic Syndrome, have a decreased risk of developing cardiovascular disease and are less likely to develop other chronic illnesses such as obesity and Type 2 diabetes mellitus (McMurray & Anderson 2010). They are also less likely to suffer from psychological disorders (Parfitt, Pavey, & Rowlands, 2009), and more likely to perform better academically (Grissom, 2005).

High-quality PE can provide students with the appropriate knowledge, skills, behaviours and confidence to be physically active (Australian Government Preventative Health Taskforce, 2010; Penney, 2010; U.S. Department of Health and Human Services, 2010), and is central to achieving physical activity and physical fitness goals in the school setting (Morgan & Hansen, 2008; Naylor & McKay, 2009; Sanchez-Vaznaugh, Sanchez, Rosas, Baek, & Egerter, 2012; USDHHS, 2010). The modification of existing physical education programs in primary and secondary schools has shown to be a popular and somewhat effective strategy used by researchers looking to improve physical activity in young people (Jago et al., 2009; Kahn et al., 2002; Quitério, 2013). Research has shown that, for some children, physical education provides the main avenue for being physically active (Bailey, 2006; Meyer et al., 2011), yet, there is increased pressure by governing bodies to reduce the amount of time allocated to mandatory physical education lessons in many countries due to increased competition with other academic areas (Dollman, Norton, & Norton, 2005; Hardman & Marshall, 2005; Puehse & Gerber, 2005). Thus, integrating mathematical content and concepts into PE can help address some of these issues. Building on this, Riley, Lubans, Morgan, and Young (2014) developed and tested the Encouraging Activity to Stimulate Young (EASY) Minds program and found real benefits in integrating physical activity into the teaching of primary school mathematics.

Mathematics and PE

It appears that for many students the level of engagement in mathematics is low and has been an area of great concern to mathematics educators and researchers in recent years (Attard, 2013). There has been a steady decline in the mathematical achievement of students in the middle school years both in Australia and internationally (Thomson, De Bortolii, Nicholas, Hilman, & Buckley, 2010). The causes of this decline in achievement appear to be varied, however, disengagement with mathematics has long been considered a factor (Martin, Anderson, Bobis, & Way, 2012). There are numerous influences that can contribute, however, factors often found to be associated with student engagement in the subject include the influence of teachers (Anthony & Walshaw, 2009) and the pedagogies employed when teaching mathematics (McKinney, Cappell, Berry, & Hickman, 2003). The middle school years are also a critical time period where students' behaviours, emotions and attitudes towards mathematics are formed and have important implications for future study and academic performance (Bishop & Kalogeropopoulos, 2015; Martin, Bobis, & Anderson, 2014). For many students, they fail to see real-life application of their learning of mathematics outside of the classroom, and potentially the overuse of traditional teacher-centred approaches in mathematics has led to them becoming disengaged (Attard, 2013). However, given mathematical enjoyment is considered particularly important for addressing student disengagement (Martin et al., 2012), improving student enjoyment of mathematics could be a key strategy to address subject disengagement (Brown, Brown, & Bibby, 2007). Innovative teaching methods and integration/teaching of mathematical concepts concurrently with PE has the potential to provide positive mathematical learning experiences and could help to enhance students' experiences and outcomes in mathematics.

To move away from what is potentially disengaging teaching practices (for many students, in the mathematics class room), emphasising and concurrently teaching PE and mathematics; students have opportunities to transfer their mathematical knowledge and skills to contexts outside the mathematics classroom. This can help address equity issues where success in the 'traditional sense' for some students is not always visible in the classroom, yet when part of a game, physical movement or other PE activity they may be better positioned to make connections to past experiences and achieve at a greater more tangible level. Further, when students recognise the interconnected nature of mathematical knowledge and PE concepts and activities, they are likely to learn to appreciate the potential to use their mathematical skills more broadly and in real-world situations.

The Australian Curriculum emphasises the importance of teaching students to recognise that mathematics is used widely outside the mathematics classroom. In relation to Health and Physical Education it;

> provides students with opportunities to use calculation, estimation and measurement to collect and make sense of information related to, for example, nutrition, fitness, navigation in the outdoors or various skill performances. Students use spatial reasoning in movement activities and in developing concepts and strategies for individual and team sports or

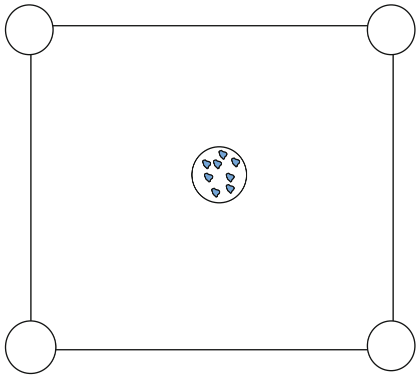
> recreational pursuits. Students interpret and analyse health and physical activity information using statistical reasoning, identifying patterns and relationships in data to consider trends, draw conclusions, make predictions and inform health behaviour and practices. (ACARA, 2015).

Putting It into Practice

Despite the many positives in being a teacher, there are many challenges including behavioural issues, under-resourcing and finding the time to cover all the material. Research conducted by the Australian Council for Educational Research through the Staff in Australia's Schools (SIAS) survey which is conducted every three years, shows that teachers' workloads are increasing. Primary teachers reported an increase of approximately 2 hours per week on school-related activities between 2010 and 2013 (McKenzie, Rowley, Weldon, & Murphy, 2011; McKenzie, Weldon, Rowley, Murphy, & McMillan, 2014). Thus, when thinking about integrating mathematics into PE it is important to think how can this be a complementary activity and not a task that will increase workload. Of note, many PE activities are already inclusive of many mathematical concepts, so perhaps it is better to think about overlaying mathematics on the PE lesson so the language used and questions asked have a mathematical focus. The following are a few examples of how such an approach can be integrated. Further examples are detailed in the lesson plans at the end of this chapter.

Example of a warm-up activity—*Rob the Nest.* Students line up in groups of three or four at each corner of a square grid (4 hula hoops approximately 20 m apart). A hula hoop is placed in the middle of the grid with approximately 20 beanbags placed in the centre hoop. Students must collect beanbags from the middle hoop and may also 'rob' another group's nest and bring the beanbags to their own hoop or 'nest'. Only one group member can collect at a time and they may only carry one beanbag at a time. The game continues until the nominated number of beanbags is collected—e.g. three or four, or play for a set time (2 minutes), team with the most beanbags wins. To enhance the mathematics of the activity numbered beanbags can be used. The team with the greatest points wins. Depending on the stage of the students, other modifications can include having

Fig. 1 Typical layout of Rob the nest



students group their numbers into odds, evens and the group with the most odds wins Fig. 1.

Another effective approach for further integrating mathematics is through data collection and subsequent analysis. Data collection can take place in the PE lesson and then use that data in the classroom for further analysis, interpretation and subsequent presentation and discussion.

For example—*Distance covered in 10 s*. Students mark out using a trundle wheel 100 m. Working in pairs students then nominate a runner, and the other becomes the recorder 'official' who determines the distance reached (by running from the starting line) in 10 s. This is then measured and recorded. The group members then change roles and repeat the process. This is then repeated until each group member has three distances. When back in the classroom the students can determine their average distance, the concept of percentage can be introduced (i.e. Samuel ran 71 m which is equivalent to 71% of the 100 m, or 0.71 of the overall distance measured out). Students could also incorporate some computer work by graphing their scores and discussing appropriate ways of presenting their findings.

These two examples highlight the potential of integrating mathematics into PE to motivate students by; providing them with a positive experience of mathematics, allowing them to have fun while learning, and they are doing mathematics with their bodies. Integration also allows for real-life connections to be made. For example, rather than reading in a question 'Samuel walked around the oval twice, now determine how far he walked', the students as part of their PE class could

Table 1 Traditional PE lesson structure

Lesson phase	Key elements of phase
1. Introduction 2–3 min	• Explain purpose and structure of lesson • Define space /boundaries for lesson • Provide demonstration of skill and overview of key points • Discuss physical activities/sports that involve the particular skill
2. Skill-specific warm up 3–5 min	• Use a fun 'warm-up' that uses the general movements and components of the skill to be taught in that lesson—all students should be active • Use questioning and introduce thinking about the particular skill and its components • Incorporate dynamic stretching, where appropriate, prior to more vigorous intensity lessons
3. Skill development 15–20 min	• First provide a demonstration focusing on key skill components and teaching cues • Ask students why each component is necessary, and keep demonstration short and simple • Provide multiple opportunities to practice the skill in a range of active, challenging and enjoyable activities • In this phase detect and correct errors in performance
4. Skill application 15–25 min	• Integrate the skill into simple of more applied games • Students should explore different ways of applying the skill • Supervise the games and provide positive reinforcement and skill-specific feedback • Ask questions about skill components
5. Closure 3–5 min	• Check student understanding through prompting the components and cues • Use questions to reinforce learning • Recognise student achievement and praise participation and effort • Students can perform stretches, light activity or co-ordination tasks during review • Ask class for feedback on lesson • Foreshadow and link to next lesson • Link to home fun activities

warm-up by doing different fundamental movement skills around the oval and when back in the classroom estimate, calculate and appreciate the actual distance since they walked/skipped/ran around the oval.

The sample 'skeleton' PE lesson plans later in this chapter provide an overview of stage appropriate activities aligned to The Australian Curriculum (Health and Physical Education, Version 8.0) and suggested outcomes and elaborations from the Australian Mathematics curriculum (Version 8.0). It is important to note that these provide only an overview of potential activities, it is suggested that if/when implementing such lessons more detailed planning be undertaken. Table 1 outlines the 'traditional' PE lesson structure.

As part of this planning, you would be considering how you will be making links to the previous lesson(s), considering assessment strategies, equipment/resource requirements, safety considerations, organisation of each activity to encourage maximum active-learning-time for all students, potential variations on activities and any follow-up activities/homework. A good resource when planning PE lessons that include a mathematics/numeracy focus is available through the NSW Premier's Sporting Challenge website (Thinking while moving, engaging with content through activity) at https://online.det.nsw.edu.au/psc/programs/getActiveInMiddleYears.html. It is important to include an introduction and closure phase to all PE lessons as detailed in Table 1. However, for the purposes of this chapter, the following lesson ideas are sample activities forming part of the warm-up, skill development and skill application phases only. The suggested differentiation strategies are largely a reflection of the Supportive, Active, Autonomous, Fair, Enjoyable (SAAFE) teaching principles (Lubans et al., 2017; Lubans et al., 2012).

Differentiation:

Modify and/or adjust activities to suit learners of all ages and abilities, and thus increase the opportunity for success. Ensure tasks are not dominated by the most competent students. Ensure students are evenly matched in competitive activities.

Australian Curriculum Mathematics Outcomes (Foundation)

ACMNA001

ACMMG010

Numeracy Links

Developing fluency with forwards and backwards counting in meaningful contexts, including stories and rhymes

Interpreting the everyday language of location and direction, such as ‘between’, ‘near’, ‘next to’, ‘forward’, ‘toward’

Australian Curriculum Health and Physical Education (HPE) outcomes and elaborations:

ACPMP008 - performing locomotor skills in any direction from one point to another.
ACPMP009 – participation in games that require students to be aware of personal safety and game boundaries

The Learning Task Foundation Year – Fundamental movement skills (FMS), Running

This lesson will get the students active, exposed to mathematical language in context and develop the locomotor skill of running.

Including ATSIperspectives:

To better provide for the learning needs of all students, consideration should be given to Aboriginal perspectives. Using the 8 Aboriginal Ways of Learning is a good framework, available at http://8ways.wikispaces.com/. Could also discuss with students that other cultures count in a variety of ways, such as the Wotjoballum number system and incorporate aspects of this into the lesson when assigning numbers.

Strategies to include learners with oral backgrounds:

In preparation for this particular lesson students can be shown video links on correct technique available from http://www.curriculumsupport.education.nsw.gov.au/primary/pdhpe/gamessport/fms002a.htm, and/or photos, and when outside students that already show competence at the skill can demonstrate.

Authentic Assessment strategies:

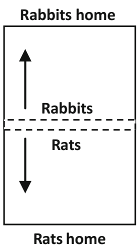
Access the Get Skilled Get Active website http://www.curriculumsupport.education.nsw.gov.au/primary/pdhpe/assets/pdf/gsga/3.%20Observing_FMS.pdf

and use the checklists available. Can also provide pictures of correct form and allow students to perform peer assessment.

Variations for students from diverse social contexts:

Rather than playing ‘rats and rabbits’, other names can be incorporated depending on the background of the students in the group. Similarly for “smoothie”, other language can be used.
To create more opportunities for success modify tasks (i.e. keep ladder drills and the mathematical component at an appropriate level for the individual).

PE: Foundation—FMS, Running

Equipment/resources required: 4 agility ladders, 4 cones, open space like a netball/basketball court, 4 soft balls		
Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Smoothie	• Line students up on one side of a basketball court or 30 m × 30 m grid • Give each student one of 3 smoothie flavours • One student in middle as the smoothie maker • Smoothie maker calls out a smoothie flavour, student(s) tries to run to other side without being tagged. • Smoothie maker calls out 'smoothie'—all students run across • Tagged students help the smoothie maker from a static position or balance (e.g. one leg)	Change to 'numbers' • Each student given a number from 1–25 • Student in the middle calls out (less than 12, or more than 11, odds and evens, etc.). • When student in the middle calls 'Numbers' all students run across
Skills practice: • Drill ladder	• Students form 4 groups • Students perform various agility runs through the ladder (e.g. one step, double step, sidestep, grapevine) • Teacher provides skill specific feedback and detects/corrects errors • Can progress activity to catch a ball at the end of the ladder run	• Have students count up by fives or other values as they step through the ladder • Have students count backwards from 10 • Have students count on from a specific number
Skill application: • Rats and Rabbits	• Two teams line up opposite one another with about 1 m between them • In pairs with where one team is the rats; the other team is the rabbits • Whichever team is called must run to their home (boundary line, or line marked by cones about 20 m away) • The other team must chase and attempt to tag their partner • If teacher calls 'rats', the rats need to run to the boundary line behind them and the rabbits must chase them • If teacher calls 'rabbits', the rabbits must run to the boundary line behind them and the rats must chase them • Each tag is worth one point 	• Can change names to left and right side • Other language of location could be incorporated such as; towards, forwards north and south

Differentiation:

It is important that each activity can be adjusted to suit the stage of the learners. Modify the tasks to increase the opportunity for success (i.e. make the goals bigger, reduce the number of defensive players, alter the equipment used, revise the task rules). Ensure students are evenly matched in competitive activities.

Australian Curriculum Mathematics Outcomes (Year 1)

ACMMG023

ACMNA012

Numeracy Links

Understanding that people need to give and follow directions to and from a place, and that this involves turns, direction and distance.

Developing fluency with forwards and backwards counting in meaningful contexts such as circle games.

Australian Curriculum HPE outcomes and elaborations:

ACPMP025 – performing fundamental movement skills involving controlling objects with equipment and different parts of the body
ACPMP030 – working cooperatively with a partner when practicing new skills.

The Learning Task Years 1 and 2– Fundamental movement skills (FMS), Kicking

Students are given the opportunity to learn through movement and further develop their object-control skills. Improved FMS in children can lead to more successful participation in a variety of physical activities and in turn likely improve their cardiorespiratory fitness (Cohen, Morgan, Plotnikoff, Barnett, & Lubans, 2015).

Including ATSI perspectives:

Some Aboriginal and Torres Strait Islander students may not have played soccer based games. Thus it is important to ensure clear demonstrations/modelling, and repetition in relation to what is expected. Could also include games and learning experiences that reflect Aboriginal culture.

Strategies to include learners with oral backgrounds:

Questioning is a key element of learning in physical education. Asking students to explain, give solutions, justify or provide alternatives within games / activities ensures that a deep level of understanding is facilitated. For students of oral backgrounds it is important to demonstrate all tasks and processes involved in each activity and promote positive social interactions between students. Allow students the opportunity to learn from one-another.

Authentic Assessment strategies:

Access the Get Skilled Get Active website http://www.curriculumsupport.education.nsw.gov.au/primary/pdhpe/assets/pdf/gsga/3.%20Observing_FMS.pdf

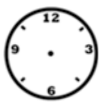
and use the checklists available.

Students could be provided with pictures of correct technique, available from the above website, and have students perform peer assessment.

Variations for students from diverse social contexts:

Students can be provided with equipment such as a soccer ball (depending on school policies) to borrow, thus enabling practice outside of class time and at home – given not all students would have access to sports equipment at home. Some cultural consideration may exist around the inclusion of girls in some sporting activities, depending on the cultural backgrounds of the students in your class. There may occasions where cultural customs mean that the sports uniform has to be altered appropriately.

PE: Year 1 and 2—FMS, Kicking

Equipment/resources required: 4 cones, enough soccer balls to enable one for each student, trundle wheel, 6 information cards for the circuit, 5 hula hoops, 4 soft balls (for heading), a marker (low profile cone), chalk to draw a clock face or if on the oval just use 4 cones to represent 12, 6, 9, 3		
Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Grid Dribble	• Students have a ball each and dribble it freely within a 30 m x 30 m grid • The teacher will call out the numbers 1, 2, 3 or 4 • 1 = stop the ball with your left foot • 2 = stop the ball with your right foot • 3 = Sit on the ball • 4 = Stop the ball, turn to change direction and keep dribbling • Continue dribbling once the task has been performed	• Change the numbers (e.g. 10, 20, 30, 40 or 100, 200, 300, 400) • Change the task and perform a set number of activities on the call (e.g. 1 = toe taps on top of the ball, teacher calls number 1 and 3 $\times$ 4)
Skills practice: • 2v2	• Students form pairs and join another pair to play a game of 2v2 in a 5 m grid • Students attempt to make 5 consecutive passes with their partner to score a point • Change possession after a point is scored, intercept is made or ball leaves the grid	• Estimate grid size • Measure grid size • Ask students to think how they could make the game harder/easier (change grid size) • Have students place a cone on ½ way line
Skill application: • Stations	• Students form groups of 4 and then rotate through stations Station 1. Keep ups—How many times can you kick (juggle) the ball (allow 1 bounce per kick)? Station 2. Cross Fire Clock. Place a soccer ball on the marker in the centre of the clock. With a partner and a ball between two, position at opposite ends of clock face 12–6 & 9–3. Aim is to knock the ball off the marker. The team who knock the ball off place the ball back. Game restarts when all are back in position. Play first team to 5 hits  Station 3. Rob the Nest (using soccer balls and dribbling) Station 4. Cross bar challenge, try to hit the cross bar with the ball off a kicking tee or cone Station 5. 2v2 soccer Station 6. Heading (soft balls)	• At station 1 have students skip count by 2, 5 and 10 s, or count backwards from 10 as they juggle/kick the ball • For rob the nest, start with 8 balls in the middle hula hoop and the first player to get 3 balls into their nest wins. Then talk to students about distances and what 'nest' is closest and therefore quickest to 'rob'. Discuss alternatives to make the game easier/harder by using more balls, increasing grid size • Use language of 'corners' and 'edges' when describing game layout • At station 4 more points awarded for kicks taken at a greater distance or smaller angle from the centre of the crossbar

Differentiation:

Modify the tasks to increase the opportunity for success (i.e. reduce the playing area, alter the equipment used, revise the task rules). Ensure students are evenly matched in competitive activities.
Use a variety of addition and subtraction questions to ensure they are appropriate for the student(s) and not at a level that will make them frustrated and become disinterested.

Australian Curriculum Mathematics Outcomes (Year 1)

ACMMG022

ACMNA015

Numeracy Links

Focusing on geometric features and describing shapes and objects using everyday words such as 'corners', 'edges' and 'faces'.

Developing a range of mental strategies for addition and subtraction

Australian Curriculum HPE outcomes and elaborations:

ACPMP025 – performing locomotor movements using different body parts to travel in different directions; performing fundamental movement skills involving controlling objects with equipment and different parts of the body.
ACPMP027 – participating in games that use a number of different fundamental movement skills.

The Learning Task Years 1 and 2 – Active play and minor games

In this session students will engage in a number physical activities and games, individually and in groups.

Including ATSI perspectives:

Some of these activities may be new for students both Aboriginal and non-Aboriginal. As such, clear instructions and expectations need to conveyed and demonstrated. Try to build informal relationships with parents and Aboriginal community members to participate in the planning, delivery and assessment of learning experiences.

Strategies to include learners with oral backgrounds:

To check for understanding, it is important to ask students to explain, give solutions, justify or provide alternatives during activities to ensure that a deep level of understanding is facilitated. For students of oral backgrounds it may be necessary to walk through an activity thus providing a clear visual picture of what is expected – such strategies are beneficial for all students.

Authentic Assessment strategies:

Use questioning in the introduction and closure phase of the lesson plus systematic observation of students participating in each activity.

Variations for students from diverse social contexts:

Use inclusive approaches to account for diverse learners and be flexible in what is expected from each individual student. Building relationships with parent and caregivers and community members will facilitate respectful conversations relating to cultural differences in expectations and inclusion in activities.

PE: Year 1 and 2—Active Play and Minor Games

Equipment/resources required: 4 cones, class set of skipping ropes, 10 soft balls		
Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Clumps/numbers	• Students move around in a grid (10 m × 10 m) using various locomotor skills (skipping, hopping, running, walking) • Teacher calls out a number and students have to form groups of that size	• Teacher calls out different shapes and students have to move into groups equivalent to the number of sides of the shape (e.g. square, triangle, cube) • Group sizing can be determined by simple addition or subtraction sums • Have students form into parallel lines and various shapes (square, circle)
Skills practice: • Skipping	• Individual skipping (1/2 feet, single, forwards, backwards, double, cross) • Skipping and moving (forwards/backwards/sideways) • Group (running in, touching ground, pairs, 2 ropes) • Introduce passing a ball (spongy ball or beanbag) while skipping • Creative time—student choice	• Students have to complete the number of skips that is a friend of ten, for example, if the teacher says 7; students have to complete 3 skips. • More difficult questions addition and subtraction problems.
Skill application: • Stuck in mud	• Use a grid approx. 20 m × 20 m • Select 3 players to be ‘it’—‘It’ players run around tagging the free players—If tagged the player becomes ‘stuck’ and has to perform a task (e.g. front support, rear support, static balance, squat position, tuck position) • Players can be freed when a free player performs the set task (e.g. runs a full circle around the stuck player, crawls through their legs or jumping over the players ankles)	• Have students develop a scoring system. For example, if you release someone you get a bonus point, if your ‘it’ you could get a point for tagging someone. If your tagged you could lose half a point.

Differentiation:

Actively monitor student progress (particularly in the circuit activity) and be prepared to modify the activities (station tasks) and provide more appropriate versions for particular students.

Australian Curriculum Mathematics Outcomes (Year 2)

ACMMG043

ACMMG038

ACMNA026

Numeracy Links

Identifying geometric features such as the number of faces, corners or edges.

Describing the characteristics of quarter-past times on an analogue clock, and identifying that the small hand is pointing just past the number and the big hand is pointing to the three

developing fluency and confidence with numbers and calculations by saying number sequences

Australian Curriculum HPE outcomes and elaborations:

ACPPS019 – demonstrating how to include others in physical activities when completing movement tasks or practising for performance
ACPMP025 – performing locomotor movements using different body parts to travel in different directions. Demonstrating balance and describing what helps to maintain stable positions.

The Learning Task Years 1 and 2 – Rhythmic and expressive movement activities, Gymnastics
Students will explore a variety of important elements of movement that complement the fundamental movement skills in the physical education strand of this course. The focus of these activities is on initial movement exploration experiences involving locomotor and non-locomotor skills, leading to the acquisition of some specific gymnastic skills.

Including ATSI perspectives:

Allow the students the opportunity to watch first then do. Where possible include games and learning experiences that reflect Aboriginal culture. These variations of commonly recognised games and those specific to Aboriginal and Torres Strait Islander groups are appropriate learning experiences for all students

Strategies to include learners with oral backgrounds:

The lesson should be a fun experience for all. Plan for non-competitive activities and make the movements meaningful. Clear boundaries and expectations should be conveyed for each activity and given adequate practice time (following clear demonstrations and oral instruction).

Authentic Assessment strategies:

The teacher could use direct observation of students participating in gymnastic related activities to assess levels of participation/enjoyment and movement sequence performed. Through questioning assess student knowledge and understanding.

Variations for students from diverse social contexts:

Safety is particularly important in this strand so learning experiences must cater for the ability of the learner and safety precautions must be carefully and thoroughly implemented. Might need to modify tasks, and ensure you acknowledge and reward participation.

PE: Year 1 and 2—Rhythmic and Expressive Movement Activities, Gymnastics

Equipment/resources required: 4 cones, music, gymnastics floor mats, hula hoop, 10 small flat markers, 2 gymnastic beams, 2 vault boards, 2 boxes		
Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Statues/freeze (with music)	• Students move around randomly in a defined area—can specify, skipping, walking, hoping, sidestepping • On cue (i.e. when music stops) students 'freeze' • Progress to calling out certain body parts (individual) to have to touch the floor on cue (e.g. 1 knee, 1 foot, 1 hand) • Progress to forming groups on cue (designated size) with specified body parts touching (e.g. 5 hands, 3 legs)	• Have students form groups and then form specified shapes with body parts (kite, triangle, circle), extend to include three-dimensional objects • Have students divide into 'equal-sized groups', then have them divide 'into groups of three'
Preparation (skill development phase): • Teach positions	• Review the skills to be taught as a class with clear demonstrations • (1) Seated straddle and tuck, (2) happy cat & angry cat stretch, (3) large arm/ankle circles, (4) individual balances (e.g. scale, lunges, vee-sit, knee scale) and (5) jump and land (e.g. Seated on motor bike)	• Relate body positions to shapes and angles (e.g. angle formed by the legs in straddle position, arc in happy cat/angry cat, 360 degrees in arm rotations and forms cone shape, right angle at the knees on landing in motor bike position)
Skills circuit (application):	• Set out 4 stations each with two components • Floor station A—log rolls/seal rolls. (Note: no more than three consecutive rolls) B—bunny hops/dog walk/bear walk • Jump and land station A—small hoop obstacle to promote jumping B—small flat markers (Lilly pad hops) step and/or jumps. • Beam statio A—mount, walking forwards/with dip and dismount. B—mount, walk sideways/crossover and dismount • Vault/beat board station A—Run up and tuck/squat onto box, stand and straight jump dismount B—Run up jump onto box then star or tuck dismount • To music, have students complete circuit twice	• Use the language of 'quarter-past times' and using an analogue clock set the time to complete two circuits • Introduce number sequences to some of the stations—students can enhance their fluency with increasing and decreasing numbers by threes, fives. For e.g. When doing bunny hops have students countdown • When students are on the beam can use the language of 'half' and 'quarter' turns

Differentiation:

Build a positive/inclusive environment and actively monitor student progress (particularly in the footloose and dice activities) and be prepared to modify the activities and provide more appropriate versions for particular students.

Australian Curriculum Mathematics Outcomes (Year 3)

ACMSP067

ACMNA051

ACMNA056

Numeracy Links

Conducting repeated trials of chance experiments such as tossing a coin or drawing a ball from a bag and identifying the variations between trials

Explaining why all numbers that end in the digits 0,2,4,6 and 8 are even and the numbers ending in 1, 3, 5, 7 and 9 are odd.

Recall multiplication facts of two, three, five and ten and related division facts

Australian Curriculum HPE outcomes and elaborations:

ACPMP048 – using cooperative skills to complete a movement task, such as a partner balance, partner passing strategy or team strategy
ACPMP050 – contributing to fair decision making in physical activities by applying the rules appropriately

The Learning Task Years 3 and 4 – Rhythmic and expressive movement activities, Dance

In this lesson students will develop non-locomotor and locomotor skills, different elements of dance, composition and sequencing.

Including ATSI perspectives:
This activity is an embodied learning experience and ideally suited for ATSI ways of learning as indicated by the 8 Aboriginal Ways of Learning, further information available at http://8ways.wikispaces.com/
There is modelling, repetition, activity based learning and hands-on/reflective techniques used. These strategies are suitable for all learners

Strategies to include learners with oral backgrounds:

The lesson should be a fun experience for all. Provide clear demonstrations and allow students the opportunity to present their interpretation of dance. The lesson could present a rich learning environment to incorporate the cultural knowledge of diverse social groups.

Authentic Assessment strategies:

Assessment should focus on the order and the way in which a movement sequence is performed. Could have students perform peer assessment. Teacher can also have informal conversations with individual or groups of students.

Variations for students from diverse social contexts:

Give students the freedom to choose the level of difficulty (e.g. when developing a dance move) and remember to praise effort and not the result. Exploring traditional and cultural dance that reflects the student diversity in your class is easily accommodated by contacting community leaders or parents who may be able to advise.

PE: Year 3 and 4—Rhythmic and Expressive Movement Activities, Dance

Equipment/resources required: 30 blank cards (A4 paper), 15 markers/pens, pre-prepared cards with dance moves 1–6 written, music		
Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Footloose	• In pairs, ask students to identify and demonstrate a signature dance move. Give names to the different dance moves identified, e.g. picking up change, running man • Students write the dance moves on numbered cards and organise the cards in a circle around the room. Example could be Station 1—Alternate elbow to knee • Provide modern music, students perform the dance moves on each card for 30 s before rotating to next station	• Incorporate the use of 'odd' and 'even' numbers. Ask students to choose their favourite 'even' dance move. Repeat for 'odd' • Opportunity to discuss why numbers are even or odd • Students can develop dance moves based on numbers
Skills practice: • Dice game	• Provide a handout to groups of 3–4 students with the following written: 1 = funky walking 2 = drop to the floor and pose 3 = twisting on the spot in a variety of ways 4 = jumping and/or leaping 5 = balancing 6 = turning as you move (or on floor) • In their groups, students take it in turn to roll the dice 6 times: (a) write down their movement sequence (b) perform the moves in the order in which the dice rolls (c) sequence together for group performance	• Talk about the possible outcomes from rolling the dice 6 times. Could all the sequences be the same, or will there be variation?
Skill application: • Composition dance activity	• Students walk around the room and listen to music. When the music stops students individually devise a set of dance steps/moves (4 beats) which involves a change of direction • Walk around the room again, when music stops students find a partner and teach each other their moves. Students put the 2 moves together to create a sequence of 8 beats • Students repeat the previous process to create a 16 beat sequence (4 students). Students perform final dance sequence for the class	• Students will need to recall multiplication facts, started with a 4 beat dance then, multiplied by 2 to get 8, then repeated to get 16. Can pose the question—How big a dance sequence could we produce if we keep on repeating the process?

The Learning Task Years 3 and 4 – Challenge and adventure activities, Orienteering

In this lesson students go on a 'scavenger hunt' within the school grounds guided by a map of the school and directions (coordinates) to set locations where they complete problems and exercise challenges.

Differentiation:

The exercises and mathematics problems on the clue cards can be tailored to suit the students' ability and alternative questions can be posed. For example a card could have; answer either exercise 1 and problem 1, or exercise 2 and problem 2. Where the second option might be an easier mathematics problem and more demanding exercise or vice versa.

Australian Curriculum Mathematics Outcomes (Year 3)

ACMMG065

ACMMG090

ACMNA057

Numeracy Links

Creating a map of the classroom or playground

Using directions to features on a map

Writing simple word problems in numerical form and vice versa. Other outcomes can be addressed depending on the mathematics problems set on each clue card.

Australian Curriculum HPE outcomes and elaborations:

ACPMP048 – using cooperative skills to complete a movement task, such as a partner balance, partner passing strategy or team strategy. ACPMP049 – drawing on prior knowledge to solve movement challenges. ACPMP050 – contributing to fair decision making in physical activities by applying the rules appropriately.

Including ATSI perspectives: When developing the mathematical problems for each location (clue), incorporating visual tasks is likely to make the problems more accessible. For example; have a number line drawn out on a long piece of paper with the instruction to half (fold) then half (fold) again to determine a quarter. Chance experiments could also be used where students have to pull out balls from a bag. Identifying symmetry in Aboriginal art could be another task (ACMMG066).

Strategies to include learners with oral backgrounds:

Students would need to be taught explicitly how to read maps. When grouping students, ensure they are mixed ability groups where they can support one another and hence focus on the group performance. The mathematical tasks and exercise challenges on the clue cards could be represented by photographs and/or real objects used for specific tasks.

Authentic Assessment strategies:

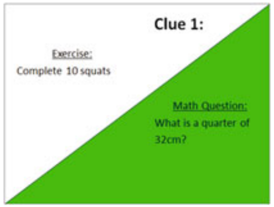
Monitor progress of each student's work as they present their worksheet on return from each location. Keep a log of each groups time to return from each location/problem. Did all the students complete a worksheet and did they solve each problem?

Variations for students from diverse social contexts:

Problems could be chosen/modified/developed to maximise the relevance to student's lives, thus making the task(s) more meaningful. Connections should be made to prior lessons and/or experiences.

PE: Year 3 and 4—Challenge and Adventure Activities, Orienteering

Equipment/resources required: Map of school with coordinates (×6), 8 pieces of paper each with a fundamental movement skill (skip to, jog to, side gallop to, power-walk to) and a coordinate that can be found on the school map, 8 pieces of paper labelled clue 1, clue 2, clue 3 to clue 8 (each clue page has a set exercise and a maths problem) and are to be positioned around the school at the respective map reference (coordinates), class set of worksheets (recording sheets), ×6 neatly cut out Tangram sets of shapes, 6 camera/ipads (optional).

Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Preparation:	• Teacher to position clue sheets at the correct map reference point around the school. Exercises at each clue can be individual or group tasks (e.g. partner balance) • In groups of no more than 4 students—each group should have a copy of the school map, and each student a worksheet and a pen/pencil  	• More than one maths task can be specified at each clue, ranging in difficulty • Each group could be timed from the start to when they return from each location. Back in the classroom group times can be compared/graphed, giving an opportunity to discuss distances, speed, etc.

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<tr>
<td>Skills application:
• Orienteering</td>
<td>• Each group is to be presented with a location (map reference) and a fundamental movement skill (FMS). For e.g. skip to L5
• At the location (where they will find the clue card) each student performs the exercise and the maths problem and records on their own worksheet
• Students then travel back to the meeting point. Here the teacher checks each student has the correct answer(s)/exercise recorded
• The group then receives another map reference and FMS
• When each group has completed 4 of the clues they need to complete a challenge question
before progressing to receive the next lot of coordinates. The challenge question could involve a puzzle or group task. For e.g. As a group complete
the Tangram. Your group must make all the shapes into a complete square</td>
<td>• In groups students could create their own locations (coordinates) and maths problems for subsequent 'scavenger hunts'
<table>
<tr><th>Clue:</th><th>Coordinates:</th><th>Answer to math's question:</th><th>Exercise to complete:</th><th>Teacher's Signature:</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
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Sample worksheet</td>
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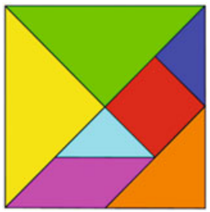
	• Students can photograph group members doing the exercises at each clue as evidence (optional) 	

Differentiation:

Consider placing students in groups of similar ability, plus batting and bowling techniques can be modified (e.g. underarm), and distances can be increased/decreased.

Australian Curriculum Mathematics Outcomes (Year 4)

ACMNA076

ACMSP095

Numeracy Links

Using known facts and strategies, such as commutativity, doubling and halving for multiplication, and connecting division to multiplication when there is no remainder.

Comparing the effectiveness of different methods of collecting data

Australian Curriculum HPE outcomes and elaborations:

ACPMP043 – exploring and practising different techniques to propel objects towards a target
ACPMP048 – modifying physical activities to ensure the everyone is included, such as changing equipment, rules or playing space

The Learning Task Years 3 and 4 – Fundamental movement skills, Striking

Cricket is one of the most popular team sports played in Australia during the summer months. This lesson will develop students striking (cricket) technique through students playing a number of modified games.

Including ATSI perspectives:

This lesson (as are the others in this chapter) is very practical and should encompass clear visual demonstrations. Need to ensure plenty of low-risk opportunities are offered to develop confidence, and the concepts can be practiced through structured and semi-structured activities.

Strategies to include learners with oral backgrounds:

Allow students the opportunity to explore the different movements and components of the skill (bowling, batting) first.
The nature of the activities in this lesson (working in teams) will help facilitate social interaction, and given the links between Australian culture and sport (cricket in this case) will encourage participation in, and an introduction to, Australian society and culture.

Authentic Assessment strategies:

Access the Get Skilled Get Active website:

http://www.curriculumsupport.education.nsw.gov.au/primary/pdhpe/assets/pdf/gsga/3.%20Observing_FMS.pdf

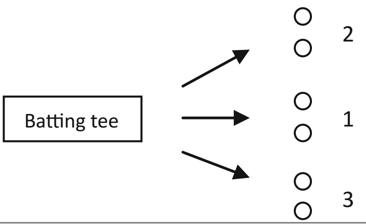
and use the checklists available.

Variations for students from diverse social contexts:

Game(s) can be modified to use baseball, t-ball equipment. The goals can be made larger (increase gap between cones), and also moved in closer to ensure all students can achieve success in scoring points. Use questions to focus students attention on the skill components.

PE: Years 3 and 4—FMS, Striking

Equipment/resources required: Set of flexidomes (or cones) with the numbers 1–20 marked on them, 4 sets of stumps, 6 soft cricket balls and bats

Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Find the answer	• Arrange numbered cones randomly in a specified area (approx. 20 × 20 m) • Have students run/skip/side gallop around in the area • Pose a question/direction. Examples; stand next to an odd number, stand next to an even number, if you add two odd numbers do you get an even or odd answer? (Stop at an odd number if you think it will be odd) • When giving the next question/problem, students move to the answer from the cone they are currently at	• Ask questions that use the language of halves, quarters, thirds • Ask questions that require mental strategies, e.g. multiply 8 by 3 and half it
Skills practice: • Target batting	• Demonstrate correct technique (Stance, grip, well balanced, and hands working in unison) • Put students into groups of 4, so multiple games can take place • Set up a batting tee and 3 sets of cones (or goals) • Each batter has 5 hits to score points by hitting the ball through the goals, then switch positions • Discuss how the game can be modified to make it easier/harder 	• Have students keep score; straight-drive = 1 point, on-drive = 2 points, off-drive = 3 points • Have students 'collect data' to investigate strike rate, percentage of success, overs bowled, average score per over for the group • Discuss the best way of recording the data and then explore ways of presenting the data when back in class (e.g. graphs)
Skill application: • Continuous cricket	• Two equal teams, one fields and bowls while the other bats • Set out 4 sets of stumps (square) and have the bowler positioned in the middle, and a batter at each set of stumps • The bowler can bowl at any set of stumps, if the ball is hit then all 4 batters must move to the next wicket in a clockwise direction • Bowler must be standing in the middle to bowl • Batter(s) can be caught out or bowled out by the bowler (only) • Fielders attempt to get the ball back to the bowler as quickly as possible • Bowler does not have to wait for the batter to be ready • If called out the play stops and the next batter runs in—play resumes	• Have batters retire after a set number of runs or a set time—can record runs for later use in class • Each run is worth 4 points and a dismissal is −3 • Have the teacher call out clockwise or anticlockwise on the hit and batters must respond accordingly

Differentiation:

Altering some of the rules of the activities can help differentiate the activities and make them more inclusive. For example a bounce could be incorporated when passing the ball. Equipment can also be altered, for example lowering the height of the hoop.
It is important to actively monitor student performance in the activities and offer feedback/correction on technique and also offer alternatives to ensure success.

Australian Curriculum Mathematics Outcomes (Year 5)

ACMNA098

ACMMG110

ACMNA098

Numeracy Links

Exploring factors and multiples using number sequences. Compare 12- and 24-hour time systems and convert between them

Using units hours, minutes and seconds.

exploring factors and multiples using number sequences

Australian Curriculum HPE outcomes and elaborations:

ACPMP061 – designing a sequence of passes between teammates to maintain possession or move a piece of equipment from one point to another. ACPMP063 – demonstrating defensive and offensive play in modified games.
ACPMP069 – correctly interpreting and applying rules in physical activities.

The Learning Task Years 5 and 6 – Games and sports

In this lesson students will further develop skills and apply rules fairly to work collaboratively while playing a number of activities based around netball.

Including ATSI perspectives:

Incorporate games from *The Yulunga: Traditional Indigenous Games* resource available from: http://www.ausport.gov.au/__data/assets/pdf_file/0017/402191/SP_31864_TIG_resource_FINAL.pdf

Strategies to include learners with oral backgrounds:

Consideration should be given when grouping students with oral backgrounds to ensure they are grouped so that other students can provide support to aid in inclusion and task understanding.
Rather than calling out numbers, an alternative could be to use hand claps, particularly for the 'numbers' game in the skill-practice phase of the lesson.

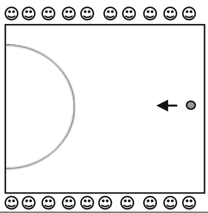
Authentic Assessment strategies:

Could use a games performance assessment index (GPAI) looking at student's game understanding as opposed to individual skill level. Due to the nature of outcomes in later stage, assessment of performance in an authentic game based environment is desirable. A GPAI is typically a collection of product and process based criteria for the sport being played, the sum of which form an assessment of overall game performance.

Variations for students from diverse social contexts:

Allow students the option to choose/modify games using the Yulunga resource. Given some students may not have a netball or access to one, allow students the opportunity to practice establish a class borrowing system to ensure that all students can have access to resources by enabling students to take them home or use them outside of class time.

PE: Years 5 and 6—Games and Sports

Equipment/resources required: 8 cones to mark out a grid, 2× drill ladders (or use chalk and draw on the concrete), 5 netballs		
Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Tag ball	• Set out a large grid (25 × 25 m) • Form two teams, one team starts with the ball and they must make quick passes amongst their teammates to get closer to the opposition players and attempt to tag them with the ball. A player cannot move when the ball is in their hands. The ball is turned over when dropped or once 10 players have been tagged • When tagged you have a special task—run to the drill ladder • The total number of tagged players is tallied at the end of the game	• At the drill ladder(s) have students call out times tables every time their foot (or feet) touch the ground. If you are the second person tagged in your team then you call out the 2 times table, third person tagged calls out 3 times table, etc.
Skills practice: • Numbers	• Students line up on the sidelines (netball court) and are given a number each (facing a partner on the opposite sideline, same number). The teacher rolls a ball down the middle and calls out 2 numbers (or 3), those students run for the ball. The first person to the ball and their teammate from the same side of the court becomes the attackers, the others are the defenders. The attackers have to work the ball down to a shot. The defenders tries to intercept or block a shot on goal, if they succeed they become the attackers and must make 2 passes before they can shoot. Game over when a shot is scored • Maximum 7–8 students per team 	• Rather than just calling numbers out, call out; even numbers or even numbers less than 5, prime numbers, multiples of 3, the remainder when 10 is divided by 3, in 24 h time what time is 15:00? • Could also talk about factors and multiples, e.g. call out factors of 10 • Give each student (pair) a larger number then use questions like: if it is 9 p.m. what time is it in 24 h time?
Skill application: • Endzone	• In teams of 4–5 students using half court(s). Team with the ball has a goalie in the end zone (can move). Goalie is rotated every time a goal is scored • Students spread themselves throughout the half court area. One team starts with the ball and must get the ball to their goalie in the end zone. Only the goalie is allowed in the end zone. All netball rules apply • Modifications—nominate number of passes to complete/designate areas students must remain into prevent crowding/vary passing technique	• Focus on the use of mathematical language (e.g. this quarter section of the court) when describing and/or modifying the game • For every pass made before a goal is scored you receive a point (i.e. 6 passes = 6 points)

The Learning Task Years 5 and 6 – Games and sports, Athletics

This lesson requires students to perform specialised movement skills and apply them in a variety of situations.

Differentiation:

Given the teachers knowledge of each student's unique strengths and weaknesses, have options for each activity, and provide clear verbal and visual instruction. Be flexible with grouping (allow student choice when forming pairs).

Australian Curriculum Mathematics Outcomes (Year 5)

ACMNA099

ACMSP119

ACMNA098

Pedagogical Strategies:

Applying mental strategies to estimate the result of calculations, such estimating the cost of a supermarket trolley load.

Identifying the best methods of presenting data to illustrate the results of investigations and justifying the choice of representation

exploring factors and multiples using number sequences

Australian Curriculum HPE outcomes and elaborations:

ACPMP061 – applying kicking, striking and throwing skills to propel an object and keep it in motion

Including ATSI perspectives:

Draw attention to the many fantastic Aboriginal and Torres Strait Islander role models that exist in athletics such as Cathy Freeman and Senator Nova Peris. Students could view the clip available at: http://corporate.olympics.com.au/olympic-feature/indigenous-stars

Strategies to include learners with oral backgrounds:

The activities (Games and Sports) offer an opportunity for social interaction, and a forum for non-English speakers to learn and practise English. In particular circuits offer a fantastic environment to encourage students to interact and support each other. Involvement in games and sports can therefore be an effective means of promoting refugees' participation in Australian society, and particularly for introducing refugees to Australian culture.

Authentic Assessment strategies:

Assessment should focus on the process. Essentially assessing the order and the way in which a movement sequence is performed. Normally assessed against a criteria checklist (e.g. FMS skills) and a score is given as a level against ideal (e.g. 5/10 criteria = developing technique). Thus, not concerned with the outcome of the sequence, just the sequence itself.

Variations for students from diverse social contexts:

Some students may have had little exposure to the movements of shot put, javelin and discuss. Enthusiastically provide information and encouragement and acknowledge and reward participation and good sportsmanship.

PE: Years 5 and 6—Games and Sports, Athletics

Equipment/resources required: 6 shot puts 2 kg, 24 hula hoops, 15 beanbags, 6 coits, 6 discuss 500 g, 6 vortex, 6 modified javelin (plastic or foam). 6 measuring tapes, pen and paper for students to record distances, 6 frisbees

Learning activities	Organisation and key teaching points	Opportunities for mathematics integration
Warm-up: • Circle swap	• In pairs (number the pairs from 1 to 12) form a class circle, standing on opposite sides to partner • Teacher calls 2–3 numbers and the pairs have to swap sides with their partner as quick as possible. For fun/challenge try it with your eyes shut! • Change the locomotor activity (hop, skip, side gallop)	• Incorporate further mathematics into the process of calling numbers out, for example, call out; even numbers, or numbers that are multiples of 3
Skills practice/application: • Circuit	• Shot put relay across oval. In pairs, students take turns shot putting the beanbag across the oval One student throws (partner beside) then they run to the landing position and the second student throws from this position (partner beside). Race to see which team gets back first and who has the least number of throws • Set up 5–6 throwing stations and outline safety protocol (very important to set strict rules). Put target hula hoops out for bonus points. Perform the shot put using a softball then real shot (3 turns at each) • Discuss • Use throwing stations from shot put (make sure they are far enough away) • Use a hula hoop or coits to practice correct action • Use a Frisbee to practice finger grip • Use real discus • Javelin • Use throwing stations and targets from shot put • Practice using the vortex and modified javelin (not the real javelin—not until high school)	• Have students 'estimate' the number of throws it would take to get the beanbag across the oval. Then have students record how many throws they took (of the beanbag) to cross the oval. Can compare actual to estimated values. Either in class or on oval have students determine their average throw distance if the distance across the oval is 50 m • Throw with the non-dominant hand and determine the average difference between left/right. Have students record multiple throws, discuss how to present the data and in class construct displays (e.g. tables/graphs) • Discuss the angle of the throw (projectile motion)

Differentiation:

Need to provide encouragement for all students and praise effort. When selecting pairs try and have them evenly matched. Monitor participation of girls and boys in all games and learning experiences.

Australian Curriculum Mathematics Outcomes (Year 6)

ACMSP147

ACMNA098

Numeracy Links

Comparing different student-generated diagrams, tables and graphs, describing their similarities and differences and commenting on the usefulness of each representation for interpreting the data.

exploring factors and multiples using number sequences

Australian Curriculum HPE outcomes and elaborations:

ACPMP064 – creating and participating in a fitness circuit designed to improve health-related fitness components. Participating in a range of physical activities and exploring their health, skill and fitness benefits

The Learning Task Years 5 and 6 – Lifelong physical activities, Improving health-related fitness

Cardiorespiratory Fitness (CRF, also known as aerobic fitness) is an important marker for health and disease in individuals of all ages. High intensity interval training (HIIT) is a feasible and time-efficient approach for improving CRF and body composition in children.

Including ATSI perspectives:

Use group work and peer support strategies to assist Aboriginal students to learn comfortably. Where appropriate, actively involve Aboriginal sporting identities, dance groups, storytellers and community members in school programs

Strategies to include learners with oral backgrounds:

Provide students with additional information through sensory experiences, real objects, models, photographs, illustrations and diagrams where possible to assist and further guide the learner. It is also important to teach students to embrace diversity and encourage friendships, thus providing social support.

Authentic Assessment strategies:

The teacher could use;
Questioning: to assess student knowledge and understanding to assess whether students value the need for regular vigorous physical activity

Direct Observation: to assess levels of participation and enjoyment in the set activities to assess students ability to effectively combine a series of skills in a game.

Variations for students from diverse social contexts:

Connections should be made to prior lessons and/or experiences and attempt to build from students' background knowledge, as well as other aspects of their personal lives.

Years 5 and 6—Lifelong Physical Activities, Improving Health-Related Fitness

<table>
<tr><td colspan="6">Equipment/resources required: 20 cones with the numbers 1–20 marked on the cones (or flexidomes), class set of heart rate monitors if available, laminated task cards for the HITT session (with pictures), stop watch, upbeat music, 4 boxing pads, 4 sets of gloves, 6 skipping ropes, circuit cards ×10</td></tr>
<tr><th>Learning activities</th><th colspan="4">Organisation and key teaching points</th><th>Opportunities for mathematics integration</th></tr>
<tr><td>Warm-up:
• Cone Flip</td><td colspan="4">• Spread 30 cones inside a 30 m × 30 m grid
• 15 cones will be up the right way and 15 upside down
• Form 2 even teams and spread around the outside of the grid
• On ‘Go’ team 1 runs in and finds one cone that is up the right way and they turn it upside down, they then run outside the grid to start again
• Team ‘2’ look for cones up the wrong way and turn them over (one cone flip then return to the outside)
• Play for 2 min
• The team with the most cones flipped will win</td><td>• Label the cones with multiples of a certain number (e.g. 7 and 9) and students in each team count how many flips they made (one team will only be flipping multiples of 7)
• Measure heart rate before and after the activity, compare to maximum heart rate 220-age (i.e. need to work above 60% Max HR to work in the aerobic threshold)</td></tr>
<tr><td>Skills practice:
• HIIT session</td><td colspan="4">• Students work in pairs and alternate between 30 s work/30 s rest for 8 exercises
• Exercises may include: push-ups, shuttle runs, bunny hops, bear walks, squat jumps, lunge walks, sit-ups, skier jumps, burpees, squats, tuck jumps (or combinations of e.g. 3 push-ups sprint 3 m and repeat)
• Laminated task cards and music are useful for these sessions</td><td>• Monitor heart rate before, mid-way, at the end and 2 min after the HIIT session
• Using heart rate monitors and the POLAR App is useful
• Graph the results and discuss maximum heart rate and anaerobic threshold (80% of maximum heart) to improve aerobic fitness</td></tr>
<tr><td rowspan="6">Skill practice 2:
• Boxing Circuit</td><td colspan="4">• Students work in pairs and rotate around a fitness circuit (1 min per station = 15 s transition, and 30 s indicator for changing roles in boxing activities)</td><td rowspan="6">• As above, monitor heart rate and record for later presentation/discussion
• If HR monitors not available, count HR for 10 s and multiply by 6 after each station</td></tr>
<tr><td>Station 1</td><td>Jab Cross</td><td>Station 6</td><td>Basic jump</td></tr>
<tr><td>Station 2</td><td>Jumping jacks</td><td>Station 7</td><td>Hook</td></tr>
<tr><td>Station 3</td><td>Heel to heel (Skipping)</td><td>Station 8</td><td>Mountain climber</td></tr>
<tr><td>Station 4</td><td>Upper cuts</td><td>Station 9</td><td>Skier (Skipping)</td></tr>
<tr><td>Station 5</td><td>Shuttle runs</td><td>Station 10</td><td>Boxing</td></tr>
</table>

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Dr. Nick Riley is a highly valued member of the School of Education at the University of Newcastle. Nick's Ph.D. study, EASY (Encouraging Activity to Stimulate Young) Minds was a school-based intervention to integrate physical activity across the Primary school curriculum and has been supported by grants from the NSW School Sport Unit.

Science and Numeracy

Mitch O' Toole and Maura Sellars

Introduction

The 2010 Australian Curriculum documents represent a sharp break with previous practice in Australian schools. They have resulted in mandated content from Foundation to Year 10 in all Australian jurisdictions. In the case of the Australian Curriculum Science (ACS), this content is set out in three columns as follows:

- Science Understanding (*SU*: things to be taught to learners),
- Science as a Human Endeavour (*SHE*: context to be exposed for learners) and
- Science Inquiry Skills (*SIS*: things to be done by learners).

The content descriptions are supported by introductory explanatory material, suggested elaborations, achievement standards and a set of very useful General Capabilities and Cross-curriculum Priorities (ACARA, 2015).

Learners already know things and they use the things they know to make sense of new experiences. Any new learning that links to unpredictable experience may lead to expected understandings, unexpected misunderstandings or some alternative conception representing a combination of the two. If something new does not connect at all with learner prior knowledge, it is likely to be ignored or quickly forgotten (Baviskar, Hartle, & Todd-Whitney, 2009). Our learning experiences are scaffolded by our families and the cultures and sub-cultures within which we grew up. Learner cultural knowledge and the extent to which school knowledge is connected to their lives will influence the extent to which students pay attention to the experiences teachers design to help them acquire supposedly socially important

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knowledge, such as science (Waldrip, Timothy, & Wilikai, 2007). 'Knowledge' that learners do not recognise as significant is discarded. Because of this, science sits ambiguously in learners' worlds. On one hand, science is school knowledge: '*teacher stuff*' at best and only of interest to '*dead privileged white males*' at worst. On the other hand, learners are immersed in the world that science claims to explain. Both things are true: science ***is*** both all around us and locked in books written by people unlike ourselves. There have long been profound concerns about the lack of impact school knowledge seems to have on learner beliefs (Caleon & Subramaniam, 2005; Pfundt & Duit, 1997) and yet science-themed media command a wide audience. This combination is odd and the very popularity of science infotainment can bring tensions between specialist and popular science to the surface (Jeffries, 2003).

Young children soak up experiences at an astounding rate and appear able to pay meaningful attention to multiple tasks, although they may make apparently unpredictable meanings. Many young children are profoundly interested in the world around them. Anybody who spends time with young children will hear many questions and often they will pile one atop the other! Many of these questions fall within that search for understanding that we call 'science' and they provide those of us who teach it with a great place to start and a wonderful opportunity for moving forward. However, something happens when these young children become young school learners and it happens much more obvious when they move between ACARA's Years 6 and 7. Children's almost insatiable curiosity about their world becomes muted and 'science' becomes something for other people. Science becomes a problem rather than an exciting opportunity. Effective teaching utilises a combination of content knowledge, learning theory and pedagogy is one version of Pedagogical Content Knowledge (Abell, 2008; Park & Oliver, 2008). The absence of any of these three components of teacher knowledge will make quality science teaching less likely. All of this is as true of the mathematical components of the now mandated science content as it is of the more recognisable science ideas.

Science and Mathematics

The entire field of science is underpinned by mathematical concepts and procedures. In this discipline, hypotheses become questions of chance and probability and answers are frequently found in the manipulation, measurement and interpretation of data, statistics, frequencies and measurements that become the empirical data. This is the evidence collected by observations and experiments and subsequently analysed by scientists. From the very simplest observations and experiments to the most complex and sophisticated, this evidence is recorded as mathematical symbols, mathematical visual organisers and mathematical formulae. The analytical component of the work of scientists is also underpinned by the logic and reasoning that is embedded in mathematics as the processes by which patterns and relationships are identified in diverse contexts, generalised and abstracted to develop formulae.

Examples of the interdependence of mathematical competencies can be found in every strand of the sciences. As early as the Foundation year in physical science, students are asked to visualise two-dimensional shape and three-dimensional objects and the ways in which they move. This not only requires that students have substantial prior knowledge of the similarities and differences of two-dimensional shape and three-dimensional objects and of their properties but also presumes that students have had sufficient experience handling and exploring these artefacts. It is simply not possible for young students to visualise these shapes and objects and the ways in which they move if they have not previously explored then tactilely. Feeling the edges, corners, examining the faces of shapes and objects, seeking out their capacities to roll, stack and pack are critical to the students' understanding of how they may visualise the movements of each and to determining the impact of the second aspect of the scientific inquiry; generalising about the properties of these shapes and objects to establish the categories or classifications to which they each belong. To this end, students need to be able to discuss how the shapes and the properties of objects facilitate or impede certain types of movement, such as rolling, sliding, etc. Students also need have had these tactile and visual–spatial experiences so that they can also reflect on the notion of size and if it larger or smaller items of the same shape or construction move differently from each other. The entire conceptual foundations of this formal introduction to the study of understanding the physical world are underpinned by learning in the mathematics strand of space.

Similarly, the science inquiry skills of year one and year two students necessitate students to be able to measure accurately (this is without overlaps or gaps) using informal measures and later, metric measures and further recording these measurements using drawings, tables and technological software. Developing these inquiry skills requires students to have established one–one correspondence, to trust the count, to count on and to have other number related competencies. Comparing measurements for discussion with peers involves the establishment of other foundational mathematical competencies. One of these is conservation of attribute, without which meaningful comparison cannot be made as it is not likely that the students will understand the critical nature of a common, level starting point from which to measure or compare their observations with their predictions, which would be based on the language of probability. Another is the recognition that both informal and formal units of measurement are required to remain a stable quantity. For example, clothes pegs joined together to make an informal measure for length need to be of equal size and formal measures using centimetres, for example, need to be equally calibrated. Students and the mathematical language, a pivotal aspect of predicting the outcomes of everyday events is the capacity to reason logically and understand the notion of 'chance' as relative to their predictions.

The primary elements of the Australian syllabus are no less dependent on foundational mathematical knowledge. The learning tasks in the year three earth and space sciences demand an understanding of rotation as a full revolution, along with sophisticated understating of time, including night and day and how these concepts relate to each other and form a pattern of daylight and darkness depending on the position of the earth which rotates on its axis. The focus on the basic tenets of mathematical reasoning and logic is further explored as the major conceptual understanding in nature and development of science for this age group and in the planning and conducting of experiments as science skill development. This is particularly important in the measuring, recording and data displays that result from experiments, tests and observations of phenomena. At this stage, students are also required to reflect on the notion of a 'fair' test and discuss logically when a test may or not be considered as meeting these criteria. Technological representation of data includes the digital development of mathematical visuals to display data, including column graphs, maps, diagrams and tables and the capacity to 'read' these digital displays and disseminate the information they represent in terms of any visible patterns and relationships. Whilst the digital construction of graphs and tables at this stage automatically formats equal calibration, spacing and structure where appropriate, students still need to use their mathematical knowledge to enter data correctly after determining measurement scale and unit of measurement and the attributes that are being measured for comparison and analysis. Interpreting this information demonstrates the students' capacities to interpret statistical data. However, they are required also to compare their predictions with the actual evidential data and develop hypotheses which explain any differences or validate their predictions. This requires a considerable application of the reflection, decision-making, explaining and validating that comprises the mathematical construct of adaptive reasoning.

Identifying and explaining pattern and relationship remains a focus throughout the middle years of primary schooling in science. Investigations that include exerting force to create movement, either at close range or from a distance provides varied and complex data depending on the scope of the distance, the objects being propelled and the force expended. This data provides fertile ground for mathematical calculations, interpreting visual data displays, matching or explaining differences in predictions and conducting 'fair' tests. The science skills and enquiry processes are also consolidated at this stage with students being required to produce data displays of increasing complexity, interpret this data and analyse for patterns and relationships; including the mathematical notions of repeating patterns and growing patterns; and become increasingly skilful at determining attributes to be measured, units of metric measurement to be used and the competent use of smaller calibrations of metric measures which include decimals to one place and fractions. Many of the activities associated with exerting force on objects and the resultant impact on the object in terms of movement also engage students in the conceptual complexity of the mathematical use of rate and ratio to explain the results of activities such as kicking a ball from various distances at a witches hat and measuring any distance travelled by the witches hat or making origami jumping frogs a standard size, half the size and double the size and recoding the number of times force was exerted to make the frog travel a predetermined distance. The comparison of the results of experiments such as these provide opportunities for students to discuss what they already experience in, for example, ball games or games that involve hitting, kicking, or throwing and travelling in a vehicle at various speeds.

The senior primary years' curriculum in science continues to rely heavily on students' mathematical knowledge, thinking processes and strategic understanding. These allow students to further develop more complex science enquiry and process skills as the facilitate the predicting, reflecting reasoning, measuring, data gathering and analysis that is integral to scientific endeavour at all levels of investigation. The various, more complex development of mathematical visuals to display and describe data are increasingly important as are the skills of interpreting data, using this evidence to create possible explanations for the results whilst considering social and cultural events and conditions which may have an impact on the explanations. The entire range of mathematical competencies; fluency, understanding, strategic competence, adaptive reasoning and problem-solving skills and strategies are integral to the purpose of scientific study and investigation. This is consistently evident in the Australian curriculum for science as it is further unpacked and examined into the lower secondary (middle school years) years of schooling. These basic mathematical ways of working with evidence, recording and interpreting data, understanding statistics and developing increasingly abstract formulae in algebraic terms are heavily relied upon as the science experimenters and investigations get increasingly more come complex, subtle and sophisticated. The capacities to make predictions, understand the mathematical potential of chance, measure diverse attributes accurately and generalise arithmetic evidence to abstract an algebraic rule or function are the foundational skills of science inquiry, not only in school contexts but are evidenced in the industrial, academic, historical and cultural endeavours in all societies through the history of mankind.

Differentiation students can experiment with other root vegetables and see if they also grow in water (they should as all their nourishment is stored in the tuber or bulb). They can measure informally using paddle pops sticks and making a mark or taping thin pieces of fine cardboard to the back of the glass and making carefully. Unifix and other materials that connect can be used to measure (paper clips, clothes pegs etc.). Later, other vegetables may be grown in the school garden.	**Australian Curriculum Mathematics Outcomes** (ACMMG006)	Numeracy Links *Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language *comparing objects directly, by placing one object against another to determine which is longer
Australian Curriculum Subject outcomes and elaborations ACSSU002 Needs of living things ACSHE013 Observation ACSIS014 Questioning the familiar ACSIS012 Sharing observations	**The Learning Task: Foundation- Pot Plants and Potatoes** In this task the students are able to see what is going on at both ends of the sweet potato as it grows in the water. They are able to appreciate what happens in the growth of what they may eat for dinner.	**Including ATSI perspectives** This activity is perfect for students in this group. These students may have a strong connection to the land and may have opportunities to grow something in their gardens at home although traditional hunters and gatherers, not farmers. The class may wish to plant other things in the school garden and may choose traditional bush tucker roots as these are Australian http://www.survival.org.au/bush_tucker_diet.
Strategies to include learners with a background of oracy: Many of these students may have the background knowledge for this task and the class may wish to try this task with other root vegetables that are commonly eaten in their diet. Although traditionally many peoples from backgrounds of oracy were nomadic, in recent times this changed and they may have had a garden in their original homeland or may have one in their new homeland. The students will be able to follow the demonstration by the teacher and their peers but may need the language associated with reflecting and explaining supported by visual materials	**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and encouraging short bursts of focussed discussion. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of group or individual plants.	**Variations for students from diverse social contexts: S**ome students may be really familiar with sweet potato, having eaten them at home as chips, baked or boiled and mashed. Many may never have seen how they grow so it may be useful to roast small cubes of sweet potato on a baking tray, sprayed lightly with oil and allow the students to taste the plant that they are growing in the glasses. Some students may want to plant these in a home garden so it is useful to be aware that only one 'eye' is required per plant and large sweet potatoes can be cut in pieces so that each one has an 'eye'

Foundation: Science—Pot Plants and Potatoes

Resources: Each group (or individual) will need one small sweet potato, four toothpicks, a drinking glass and water. The sweet potato needs to be small enough to fit into the drinking glass with one-half sticking out the top and the other just above the bottom of the glass.

Background for teachers

Science in the Early Years is predominantly a matter of directing children's attention to parts of their environment that they may not otherwise notice and redirecting them before their interest wanes. Unexpected connections between parts of that environment can generate and sustain considerable situational interest.

Science Concepts:

Plants are composed of roots, stems, leaves and some reproductive part, such as a flower or a cone. Some plants reproduce through these and others can reproduce from cuttings or tubers. Sweet potato (called '*kumera*' in some parts of the world) is a very useful plant with a starchy tuber that is very tasty when it is cooked. Sweet potato can reproduce from this tuber or from flowers that grow from their stems. Many children will only have seen a sweet potato in bins in the fruit market and they the idea that this vegetable can grow into something that is recognisable a plant can evoke considerable enthusiasm. This activity allows children to watch the vegetative reproduction of a sweet potato. If the water is topped up, the potato will grow roots from its bottom half and stems and leaves from its top. If left long enough, some potatoes may flower.

Implementation:

Activity Origin: Adapted from Hinkler 2015, Activity 65.

Each group/individual should:

- Fill the drinking glass with water.
- Stick toothpicks around the middle of the sweet potato, so that they are evenly spaced.
- Place the potato into the glass.
- Make sure that the bottom of the potato is in the water.
- Place the 'potato-in-water' equipment on a shelf where they are in the sun for part of the day.
- Check their potato every day.

Reflection Activity: *, **

Each day, each group should discuss what has happened to their sweet potato.

- Are different things happening to different ends of the sweet potato?
- How much time passed before something happened?
- How could the group keep a clear record of what happened when?
- What does this activity show about plants?
- How could we measure the plants?

Differentiation: After the initial explorations, students may be able to experiment with bottles of different sizes and then place in order of how they would like the pitch to alter and adjust the water level accordingly. They can make a video of their activities in groups and discuss the ways in which they were able to vary the sound. Some may be able to explain that the sound depends on size, shape and volume of water.

Australian Curriculum Mathematics Outcomes

(ACMMG006)

Numeracy Links

*Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language

**comparing objects directly, by placing one object against another to determine which contains more

Australian Curriculum Subject outcomes and elaborations

ACSSU020 **Making & sensing sound**
ACSHE021 Questioning & describing
ACSHE022 Using science
ACSIS025 Investigating with guidance
ACSIS212 Compare observations with descriptions, through discussion

The Learning Task: Year One – Musical Bottles

This lesson allows students to make sound and to use water levels in bottle to vary the pitch. It can lead to many opportunities for discussion and for further exploration of sound and making sounds

Including ATSI considerations: These students may have experiences with traditional instruments and the class may be able to experiment with vibration and sound in the context of some of these traditional musical instruments

http://www.didjshop.com/austrAboriginalMusicInstruments.htm

Strategies to include learners with a background of oracy: these students would have traditionally not had many if any possessions, being nomadic, however the drum was a staple at all ceremonial and community celebrations. These students may be familiar with drums, the decorations and the different sounds that they make when varied. The class may like to investigate sound and vibration using home- made drums of different sizes or a bucket band with different sized buckets. See https://www.google.com.au/search?q=home+made+drums+for+children&espv=2&biw=1440&bih=862&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwivwL_zyM

Authentic Assessment strategies: Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and encouraging additional 'experimentation' with the instrument. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class performance on the instruments and explanation of their operation.

Variations for students from diverse social contexts: Music is common across all cultures, social and economic classes and castes. In some circumstances the types of music that students know and enjoy can be indicative of their background and their cultural origins. You may find that students with diverse backgrounds may want to make music in different ways and enjoy certain types of rhythm and combinations of sounds. See https://www.youtube.com/watch?v=rkHLGxG68 Be aware that the US is represented by the national anthem and the images include soldiers in full battle dress which may distress some students with refugee experiences

Science: Year 1: Musical Bottles

Resources: Each group (or individual) will need five identical glass bottles, a plastic jug, access to water and a spoon or fork.

Background for teachers

Young children enjoy making sounds. This activity allows them to deliberately change the sound they make and exposes them to a couple of technical words ('pitch: high/low' and 'volume: loud/soft' that they can use to describe the changes that they make.

Science Concepts:

Things that move backward and forward (*vibrate*) quickly make sound and sounds have two fundamental qualities: *pitch* and *volume*. Pitch is the technical word used to indicate whether a sound sounds 'high' or ' low'. Volume is used to indicate whether a sound is 'loud' or 'soft'. Hitting (or plucking) something strongly produces loud sounds. Make it move backward and forward more quickly and it will produce high sounds. Slower vibrations cause lower sounds. This is as much explanation (and technical vocabulary) as should be expected from a one-year child.

Vibrating objects push and release against their surroundings and this sets up regular movement through fluids: waves. Our ears respond to these waves and we call it 'sound'. The compressed air hits our eardrum, there is a pause and then the next compression hits. We hear the size of the compression (*amplitude* of wave) as volume and the time between them (*frequency* of wave) as pitch. Thinner, or lighter, objects vibrate more quickly (*at a higher frequency*) than thicker, or heavier, ones. This explains why the thinner strings on a guitar sound higher when plucked and why the bottles holding more water sound lower in the activity that follows.

We (and elephants) can also 'hear' very low-frequency waves through our chests. You might have noticed this at pop concerts: you hear the falsetto lead vocal with your ears and the bass guitar and drums through your diaphragm!

Lesson:

Activity Origin: Adapted from Hinkler 2015, Activity 245.

*Each group should:

- Put the bottles in a line.
- Add water to the bottles: a little water in the first and then a little more in each as they move up the line.
- ***Gently*** hit each bottle in turn with the spoon (or fork).
- ***Gently*** hit the bottles in any order.

Differentiation:

There is no way to differentiate this activity authentically but the actual use of the paper for Mother's Day card or other personal use gives the students opportunities to make personal choices and decisions.

Australian Curriculum Outcomes

(ACMMG038)

Numeracy Links

*Compare masses of objects using balance scales

**Using activity sequence and reasoning to solve problems.

Australian Curriculum Subject outcomes and elaborations

ACSSU031 **Mixing on purpose**
ACSHE035 Recycling
ACSIS038 Manipulating materials

The Learning Task: Year Two – Making paper

This is a step by step guide to making paper with young students. It clarifies exactly what the teachers must do themselves and the steps that the students must carefully take to get an understanding of the process of recycling.

Including ATSI perspectives: Like the other students from oral traditions, these students historically had no use or need for paper. However, their conservation and caring for the land created an environment where there was no need for recycling. No wasted paper and no littering at random. Traditional customs differ from those used today but there are some famous examples of ATSI recycling. The class might like to see some activities. http://australianmuseum.net.au/blogpost/museullaneous/recycling-off-the-beach-aboriginal-artists-and-ghost-net-at-pormpuraaw Following explicit, linear, direct

Strategies to include learners with a background of oracy: These students would not have traditionally had any use for paper. However, in a print dominated world it may be interesting for these students to participate in this activity and use their own paper for some special purpose. Like the ATSI students, the introduction of narrative and action with the task can enhance student learning. All the students may like to decorate their paper with tradition symbolic design.

Authentic Assessment strategies: Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and reminding them of the use of such paper for gifting purposes. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of their recycled paper.

Variations for students from diverse social contexts:

Paper may have been a vital and useful commodity for some of these students and been in short supply. It may be valued for its unique characteristics as their personally created paper. However, some students may not value recycling or the notion of creating something as ordinary and everyday as paper. Despite different attitudes that may be present in the class, the processes of this lesson are valuable as demonstrating the conceptual understanding of recycling materials to make something new and usable.

****Reflection Activity**:

- How could you describe the sounds that you have made?
- What changed the sounds that you made?
- Can you play a tune on your bottles?
- Can you explain how your musical instrument works?

Science: Year 2—Papermaking

Resources: The class will need one bottle of liquid detergent, one bottle of household bleach, a large transparent glass mixing bowl, a square of metal fly screen (approx. 20 cm a side), access to water and a sink, a stainless steel tablespoon. Each group (or individual) will need a quarter of a sheet of old newspaper (about 30 cm by 20 cm), a pair of scissors, a metal egg ring, a square of metal fly screen (approx. 10 cm a side), a small transparent glass mixing bowl, a stainless steel teaspoon, an old newspaper to protect their table, a clean dry tea towel and a sheet of clean dry cardboard.

Information for teachers

Cheap, light and flexible writing material was very important in the development of civilisation and paper meets that need today. Paper was invented in China around the Second Century, filtered west through Eurasia to Baghdad by the middle of the Eighth, to Spain by the Twelfth and was in general use in Europe by the Fourteenth Century, just in time for the invention of the printing press. Paper was originally made from such things as waste cloth and straw (hence the derogatory reference to newspapers as ‘filthy rags’) but it has been made from pulped wood since the Nineteenth Century. This has had a rather negative impact on the world’s forests. Paper is not hard to make from other paper and this led to it being one of the first materials to be widely recycled. This activity demystifies a common material for young children and helps them understand why waste for recycling is sorted before collection. This activity takes place in two phases.

The activity requires that the teacher use bleach to prepare old newsprint for recycling as ‘artisan paper’. The children should NOT carry out that phase of the activity for themselves. The activity MUST be trialled before use with a class. As bleach is not allowed in some school environments, the bleaching process may be done at home, preferably outside.

Science Concepts:

Paper is a compressed mat of fibres that can be easily smoothed, coloured and decorated. The fibres are usually *cellulose*. The stringy stuff in celery is the most commonly encountered example of cellulose. Pressed, tangled fibres of cellulose will stick together as they dry to form paper.

Differentiation: Almost any pantry ingredient can be used in this task. A range of material may include those that change dramatically during the freezing process such as fresh vegetables and fruit. The groups may all have different materials and compare their changes to the materials selected/ provided for the other groups.	**Australian Curriculum Mathematics Outcomes** (ACMMG061)	**Numeracy Links** *Measure, order and compare objects using familiar metric units of length, mass and capacity **recognizing the importance of using common units of measurement
Australian Curriculum Subject outcomes and elaborations ACSSU046 **Change of State** ACSHE050 Making predictions ACSIS053 Scientific questions ACSIS055 Safe use of materials	**The Learning Task: Year Three-Freezing** This task requires students to investigate what happens when materials are frozen. It raises questions about what might freeze and thaw successfully and what may not. The students can be encouraged to think about the scientific concepts –particularly that relating to water content of materials as an important consideration in the freezing process.	**Including ATSI Perspectives:** in certain parts of the country materials would freeze naturally, in other parts the notion of freezing would be very foreign indeed. Australia is always thought of as hot! The class could investigate groups who inhabited the colder parts of Australian traditionally. This activity suits this group of students as the nature of the learning is congruent with 'planning and visualising explicit processes' https://intranet.ecu.edu.au/__data/assets/pdf_file/0016/510073/8-Aboriginal-ways-of-learning-
Strategies to include learners with a background of oracy: Perhaps the most inclusive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning.	**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and exploring their differing experiences of temperature. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of applications of food chilling.	**Variations for students from diverse social contexts:** Many students would need no introduction to the ideas of freezers and freezing. (a number of students may live on frozen meals and fast foods). The most supportive strategies may be to ensure that the ways in which the instruction is given is explicit and is easily understood by the students and that the scientific concepts are explained in ways that the students can relate to their own experiences.

Lesson:

Activity Origin: Adapted from Brothers, Gow & Mackay 1983, p. 754.

*Each group should: (i) Weigh their newspaper on the balance scales using dienes equipment then tear or cut their piece of newsprint into pieces about 2 cm square. (ii) Pass their pieces to the teacher. The teacher should (i) Place the newsprint pieces into the glass mixing bowl (ii) Cover the pieces with household bleach (iii) Slowly stir the mixture with the table spoon for about 5 min. The mixture should form a uniform grey pulp (iv) Put the mixture in a safe place and let it stand overnight.

Next day, **(i) pour the contents of the bowl, through the larger metal fly screen square, into the sink (ii) Carefully, use the table spoon to scrape the pulp off the mesh and put it back into the mixing bowl (iii) Wash the pulp with water in the bowl and then pour it back through the mesh (iv) Repeat the washing three times (v) Mix a table spoon of detergent with the pulp in the mixing bowl and then wash the mixture another three times (vi) Return similar amounts of yellowish pulp to each of the groups.

Each group should: (i) Spread the newspaper over their table (ii) Use the teaspoon to place their mound of yellow pulp, in the egg ring on the metal fly mesh, over the small mixing bowl (iii) Rock the mesh gently as the water drains into the bowl (iv) Gently remove the egg ring from the wet mat of yellow pulp (v) Lay the mesh, with the wet mat on top, on the newspaper on your table (vi) Fold the tea towel in two and lay it over the mesh (vii) Reach under the tea towel and put one hand under the mesh. Place the other hand on the tea towel (viii) Turn the tea towel over, so that the tea towel is under the wet mat of yellow pulp and the mesh is above mat (ix) Carefully lift the mesh off the wet mat of yellow pulp (x) Fold the tea towel to cover the wet mat of yellow pulp (xi) Place a piece of strong, dry cardboard on the tea towel above the mat and press it as hard as possible. This should squeeze out the remaining water (xii) Take away the cardboard and lift the top flap of cloth. The mat should have become a sheet of wet yellow paper (xiii) Peel the wet paper disc carefully off the tea towel and put it on a sheet of dry paper or cardboard. You have made recycled paper!

Reflection Activity:

What happens to the ink from the old newspaper? Why did the teacher wash the mixture(s) so many times? Describe places where you have seen this sort of paper before. Will the paper weigh the same as it did before the process? Give reasons.

Science: Year 3—Freezing

Resources: Each group (or individual) will need access to water, vinegar, tomato sauce, bread, rice, butter and other household substances; a container for each substance (small yoghurt containers or an ice tray, depending on quantity), access to a freezer. One set of kitchen scales per group.

Differentiation:

Due to the precise nature of the experiment and the safe use of materials involved, this may not be easily differentiated. However, different materials may be used after the initial experiment to further research the concepts of heat transfer using solids. Then these may be compared with the liquids in this experiment.

Australian Curriculum Mathematics Outcomes

(ACMMG061)

Numeracy Links

*Measure, order and compare objects using familiar metric units of length, mass and capacity

**recognizing the importance of using common units of measurement

Australian Curriculum Subject outcomes and elaborations

ACSSU049 **Conduction**
ACSHE050 Making predictions
ACSIS053 Scientific questions
ACSIS055 Safe use of materials
ACSIS058 Fair tests

The Learning Task: Year Three (ii) Ouch! That Burns!

This task involves the students investigating heat in an experiment that focusses on safe use of materials

Including ATSI perspectives: This is an activity based task does suit the ways of making meaning which are used by this group. However, many students in the class may find difficulty following explicit instructions in a linear manner as this does not support their ways of learning. The task itself is connected to the natural world and to country. It can be easily embedded in narrative for the class https://8ways.wikispaces.com/Aboriginal+pedagogy+research+review

Strategies to include learners with a background of oracy:

Perhaps the most inclusive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds.

Authentic Assessment strategies:
Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and engaging them in conversation about the application questions. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class design of the 'perfect cup'.

Variations for students from diverse social contexts:

The conceptual understandings related to this lesson are heavily embedded in specific language. To support all students this language needs to be investigated, to be defined and to be made accessible.

One way to do this is to engage the students through narrative, through the drawing and describing and through group and peer discussion.

Background for Teachers

Many homes have domestic freezers and the food is either bought frozen or chilled for later use. This activity is designed to focus child attention on a common kitchen phenomenon.

Science Concepts:

There are three common physical states of matter, solid, liquid and gas. Materials change their state when they lose or gain energy. Most children experience this energy as heat and variations as changes in temperature. Different materials are in different states at different temperatures. The temperatures at which a material changes state are its freezing, melting and boiling points. Pure water freezes at 0 °C and boils at 100 °C. The freezing and boiling points of water will change if it is not pure.

Lesson:

Activity Origin: Adapted from Hinkler 2015, Activity #129.

Each group should:

- *Weigh the materials according to the size of the containers and the nature of the material (5 g increments. The containers should be placed on the kitchen scales and the dial reset to zero. This need to be done each time a different container is used. Food can be weighed in one container and transferred to another neatly if desired.
- **Each group needs to estimate and then decide how much of each material they are putting in their containers and add it to the description.
- Place each material in a separate container.
- Draw a picture of each and describe it.
- Put the containers in the freezer overnight.
- Check the containers next day.

Reflection Activity:

- Describe any changes you see?
- Why do we cool foods like this?
- Is there any difference in the changes for the materials when they are different weights?

Science: Year 3—Ouch! That burns!

Resources: Each group (or individual) will need access to hot water (NOT boiling), one drinking glass, one metal mug, one pottery cup and one polystyrene cup. Measuring cups with calibrations.

Background for teachers

Heat flow is one of the most common experiences for growing children but they still seem to burn themselves. This activity focuses on the insulating properties of some materials.

Differentiation: there are a number of ways in which this task can be differentiated. The students can explore what happens when magnets get together, when they are near a variety of different metallic objects – what reacts and what doesn't- they can develop a facts sheet about magnets and how they work, what they used for in industry, how they react with various technology and so on.

Australian Curriculum Mathematics Outcomes

(ACMSP092)

Numeracy Links

*Describe possible everyday events and order their chances of occurring

****using lists of events familiar to students and ordering them from 'least likely' to 'most likely' to occur**

Australian Curriculum Subject outcomes and elaborations

ACSSU076 **Action at a distance**
ACSHE061 Predicting and describing relationships
ACSIS216 Compare results with conclusions

The Learning Task: Year Four - Magnetism

This task explores the magic of earth forces, magnets and magnetisation and direction including the cardinal points

Including ATSI perspectives:

Students may prefer to learn by repetition of another's example but the will be able to carry on from this original experiment by examining the whole, then the parts of the experiment and deconstructing and reconstructing the steps along the way with the examination of the non-verbal cues.
https://8ways.wikispaces.com/Aboriginal+pedagogy+research+review

Strategies to include learners with a background of oracy:

Perhaps the most supportive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. The class may enjoy this lesson embedded in narrative.

Authentic Assessment strategies:
Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and guiding the discussion of magnets. Children often already know quite a lot about magnets. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class discussion of the role and use of magnets.

Variations for students from diverse social contexts:

Most students will enjoy investigating this area of magnetism. Some students who have more sophisticated understandings of technology and computers may be able to explain how they work together, why credit and other cards with magnetic identifying strips and similar devices should not be stored next to magnets.

Science Concepts:

Heat flows through contact (*conduction*), expansion (*convection*) and flight (*radiation*). Some substances conduct heat better than others. Solids conduct heat better than liquids, liquids conduct heat better than gases and empty space will not conduct heat at all. Metals conduct heat better than glass, glass conducts heat better than pottery and pottery conducts heat better than polystyrene. Polystyrene is a solid foam of plastic with gas inside the bubbles. It slows down conducted heat (*insulates*) so well because the heat has to get around the bubbles.

Lesson:

Activity Origin: Adapted from Hinkler 2015, Activity #128.

Each group should:

- *, **Fill the four containers with the same amount of hot** water.
- Gently and carefully place your hand around each container, one at a time.

Reflection Activity:

- Why were you asked to touch the cups 'carefully and gently'?
- Why were you asked to use the same amount of water in each cup?
- Which container felt hottest?
- Which container felt coolest?
- Which container would you use to keep chocolate hot on a cold night?
- Which container would you use to cool down a hot cup of soup?
- What would be the perfect drinking cup?

*Science: Year 4—Magnetism

Resources: Each group (or individual) will need a needle, a magnet, a pair of scissors, a small piece of cardboard, a jar, thread, a pencil and a magnetic compass.

Background for the teacher

Magnetism looks like magic: things move without being touched and unseen forces resist human effort. It is no wonder that children (and adults) find magnets fascinating. This activity depends on class access to magnets, which can be bought fairly cheaply from hobby or toy shops.

Science Concepts:

The Earth has a core with two layers that are not moving together. The relative movement between the two huge concentric balls produces a magnetic field, within which we all live. This *geomagnetic* field allows migrating animals to navigate and makes some substances behave very strangely on the earth's surface. They attract iron, attract and repel each other and indicate direction if left free to move. We call these things 'magnets'. They are not magic; they are just arranging themselves in the geomagnetic field.

Differentiation: There are a number of ways in which this task can be differentiated. The students can explore what happens when a variety of other substances are subjected to the sun's energy. Are they solid or liquid? Students can make predictions based on prior knowledge and experiences but the task can be made increasingly complex by heating something that is part liquid, part solid and asking for explanations and reasoning from the students.	**Australian Curriculum Mathematics Outcomes** (ACMSP116)	**Numeracy Links** *List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions
Australian Curriculum Subject outcomes and elaborations ACSSU043 **States of matter** ACSHE217 Benefits of fuels in different states ACSIS093 Varieties of communication	**The Learning Task: Year Five – Solids, Liquids and Gasses** An introduction to the particle model of matter.	**Including ATSI perspectives:** Students may prefer to learn by repetition of another's example but they will be able to carry on from this original experiment by relating it to their knowledge and understanding of the land and the impact of heat on various liquids. Using narrative in this context will support learning shttps://8ways.wikispaces.com/Aboriginal+pedagogy+research+review
Strategies to include learners with a background of oracy: Perhaps the most supportive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. The class may enjoy this lesson embedded in narrative	**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their understanding by managing whole class discussion to draw out the classroom image with which the Science Concepts section ended. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class enactment of the particulate explanation of change in state.	**Variations for students from diverse social contexts:** The language in this lesson may need to be simplified and to be gradually defined within the conceptual understanding of the task. The students could describe/ write what happened in their own words before engaging with the vocabulary on the whiteboard. They can the substitute any words they have not used (or used correctly) from the list in their activity descriptions so that they have a draft with their own explanation and a draft with the metalanguage required for the more scientific report

Lesson:

Activity Origin: Adapted from Hinkler 2015, Activity #238.

Each group should:

- Stroke the needle with the magnet to magnetise it.
- Tie one end of the piece of string to the small piece of cardboard and the other to the pencil.
- Push the needle through the piece of cardboard. Make sure that the middle of the needle rests in the middle of the cardboard.
- Lay the pencil across the mouth of the jar to hang the piece of cardboard inside the jar. Set the length of the string so that the cardboard does not touch the bottom of the jar.
- The cardboard should turn on the string.

Reflection Activity:

- What is turning the cardboard?
- In which direction does the needle points?
- Explain what you see.
- Why do you think this is happening?
- *Make predictions about the chance of the same thing happening in your next experiments. **Record your predictions using the terms from 'most likely' to 'least likely'
- Repeat but without stroking the needle with the magnet- has anything changed?
- Repeat and pass the magnet through the cardboard but not through the centre-what happens—has anything changed?
- Using all these findings, develop some ideas about the reasons why the fits experiment worked but the others were not so successful
- Test the experiment again with your own ideas to see if you have come to the correct conclusions regarding why the first experiment worked and the others were not as successful.
- **Write up your findings and illustrate showing the experiments you performed.

Science: Year 5—Solids, Liquids and Gases

Resources: Each group (or individual) will need a brick, a large block of ice, a saucepan, a heat source (like the sun on a hot day).

Background for teachers

The Australian Curriculum begins to move children's science towards that expected at later stages of schooling in Year 5. This activity forms part of the introduction of the particle model of matter.

Science Concepts:

There have been two historic views of the nature of stuff (*matter*). One has seen matter as essentially *continuous*. That is, stuff is shoved up against other stuff, with no space in between. The other view is that matter is made up of smaller bits of stuff that are eventually hanging around together but not touching (*particulate*). These views are sometimes called theories or *models* because the particles are invisible. Modern science is based on the particulate model, which leads to the conclusion that everything is pretty much nothing because the spaces between are so much bigger than the particles when we get small enough. This sounds pretty silly, and some fairly intelligent people (Ernst Mach for one) have disbelieved it, but it does allow us to explain things that the continuous model cannot. That is the definition of a successful model in science. Children often find it a bit silly, too. After all, where are the holes? The states of matter are where they get introduced to the model.

Solids have a definite size and shape because the particles are close together and moving just a little. *Liquids* have a definite size but not a definite shape because the particles a little closer but they are sliding around each other. *Gases* have no definite size and no definite shape because the particles are far apart and keep shooting off in all directions.

Energy is the key to this model. The particles in solids have less energy than those in liquids, so they stay in place. The particles in a gas have more energy than those in a liquid, so they break away from each other. If we take energy from a gas, it will *condense* to form a liquid, which will *freeze* to form a solid if we keep pulling out energy. Remember Activity 4?

A class of students is a common image for this: a solid during the lesson, a liquid when the lesson ends and a gas in the playground.

Lesson:

Activity Origin: Adapted from Brothers, Gow & Mackay 1980, pp. 62–68.

Write the following words on the board: *size, shape, definite, melt, boil, evaporate, solid–liquid, gas*

Each group should:

- Compare the brick and the block of ice
- What are the good criteria for comparison? Make a list
- *Predict what might happen in the experiment
- *Use a fraction to describe the chance of your experiment resulting in your prediction
- Put the ice in the saucepan and begin to heat it slowly (this can simply be done by putting them outside in the sun on a hot day)
- Describe what happens.
- *Predict—what would happen to the brick if you did the same to that?
- *Predict what may happen to a variety of other substances

Reflection Activity:

- How are the brick and ice similar; how are they different?
- What happens to the shape of the ice block as you heat it?
- How could you explain this?
- Write out your explanation.
- What happened to the shape of the brick?

Differentiation: It is rather complex to try and duplicate this experiment to illustrate how and earthquake happens but it is possible to simulate realistically with technology or with a hands on activity using marshmallows and toothpicks

https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_natdis/cub_natdis_lesson03_activity1.xml

Australian Curriculum Mathematics Outcomes and elaborations:

(ACMSP144)

Numeracy Links

*Describe probabilities using fractions, decimals and percentages

Australian Curriculum Subject outcomes and elaborations

ACSSU043 **States of matter**
ACSHE217 Benefits of fuels in different states
ACSIS093 Varieties of communication

The Learning Task: Year Six – Tsunamis and Earthquakes

An experiment that illustrates the actions of the earth plates and the resultant upheaval that causes these natural disasters

Including ATSI perspectives: This is an activity based learning opportunity that is linked to the land and not necessarily language based. The actions themselves are indicative of what occurs, as is the Aboriginal legend of how the earth was created, which includes some very serious understandings of earth movement and the creation of landforms. This could be used respectfully to enhance the modern scientific understanding of the forces that break through the earth's crust and the movements that create these natural phenomenon but this is controversial for some http://www.upfromaustralia.com/dreamabstoro.htmlhttps://8ways.wikispaces.com/Aboriginal+pedagogy+research+review

Strategies to include learners with a background of oracy: Perhaps the most supportive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. Throughout the world, all cultures and peoples have had their own stories about the world, its natural ways moving and the subsequent earthly upheaval so it may be interesting for the class to investigate some of these. Integrating traditional stories with modern scientific explanation is controversial for some. Care is needed. Some students may have experienced these natural disasters

Authentic Assessment strategies: Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and enhancing the realism of the tsunami simulation by adding additional detail or asking open questions about the group response to their observations. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of group explanations. Their predictions also show understanding of the impact of the force with which these movements occur

Variations for students from diverse social contexts: Some students in this group may have experienced one of these natural disasters. The language in this lesson may need to be simplified and to be gradually defined within the conceptual understanding of the task. The students could describe/ write what happened in their experiments in their own words before engaging with the formal vocabulary. They can the substitute any words they have not used (or used correctly) from the list in their activity descriptions so that they have a draft with their own explanation and a draft with the metalanguage required for the more scientific report

Science: Year 6: Earthquakes and Tsunamis

Resources: Each group (or individual) will need a deep baking pan, access to waterand two blocks of wood. Optional requirement are, toothpicks, a bowl of jelly and marshmallows for each group (enough marshmallows and toothpicks for each group/pair/individual to make a basic 'house' shape.

Background for teachers

Disasters seem to fascinate students and Earth Science helps us to understand them as moderately predictable consequences of the way our planet is constructed, rather than the capricious whims of a vengeful nature. Care should be taken with classes which may include children with the personal experience of any of these disasters.

Science Concepts:

The *crust* of the Earth is made up of a number of solid *plates* which a floating on a liquid *mantle*. We live our whole lives on the top of these slowly shifting blocks. Plates are being formed where mantle material rises through cracks in the crust and destroyed where one plate plunges underneath another. Such movements explain volcanoes, earthquakes, tsunamis, landslides and other natural disasters. Plate movement can cause earthquakes, which in turn trigger underwater landslides, which in turn set up strong waves in the sea nearby. These waves may be relatively harmless in deep water. The disturbed water simply rolls in large surges above the sea bed. However, if the wave moves into shallow water, it can suck back water from harbours and then rush in as very high waves. 'Tsunami' is the Japanese word for 'harbour wave' and it gives these disasters their name.

Lesson:

Activity Origin: Adapted from Hinkler 2015, Activity #236.

Each group should:

- Fill the pan with water and take it outside to a grassy area.
- Push the two blocks of wood completely under the water in the pan.
- Hold the blocks and move them together quickly.
- Repeat this until the blocks can no longer squeeze the water.
- Watch the way that the blocks coming together below the water makes waves at the surface.

Reflection Activity:

- What happened to the surface of the water when you moved the blocks together on the bottom of the pan?
- Describe how this might explain disasters at sea.
- Can you use this experiment to explain how earthquakes occur?
- There is a measure of the energy released from earthquakes that can be measured by seismic waves (Richter Scale)

- How would you measure the energy expended as you banged your black together under the water?
- What might happen if you have been more gentle? Less forceful?
- *Repeat the experiment several times and predict the chance of displacing all the water in the baking dish in a specific number of actions, e.g. chance of it happening in 3 strong forceful actions, 6 soft actions, etc. use decimals, fractions and % for your predictions.
- If investigating the earthquake with house models using toothpicks and marshmallows, make the same predictions about your 'house' and the bowl of jelly

1. Year 7: What is 'pure'?

Science in secondary contexts is a separate subject, with specialist teachers and specialist spaces. This lesson is written for a double practical period of about 80 min duration.

Science Concepts:

Most natural materials are mixtures of different things. For example, sea water is a mixture of water, common table salt and small amounts of other salts. The different parts of a mixture have different particle sizes, boiling points, melting points, densities and solubilities. These are physical properties and we can use them to separate the different parts of a mixture. So we can dry out sea water to get the salt out of it. When we have tried all the ways of physical separation, what we have left is a pure substance. For example, if we cannot separate the salt any further, we have pure salt. This lesson applies this science to the problem of providing safe drinking water.

Lesson:

Activity Origin: Adapted from Brothers, Gow & Mackay 1977, p. 98.

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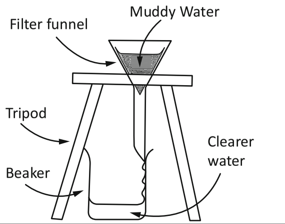
<td>
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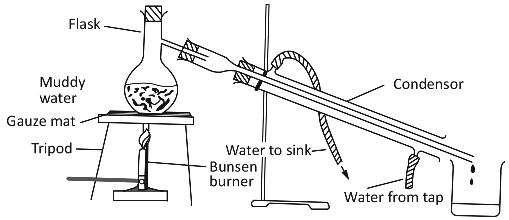
<td>
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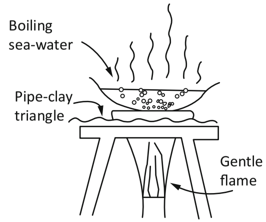
<td>
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<td>Equipment
(for one set of stations)</td>
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<tr>
<td>Station 1
Filtering
1. Put an empty beaker under the tripod
2. Wet the inside of the funnel with water
3. Put the funnel into the tripod, so that its tube is inside the lip of the beaker
4. Fold a piece of filter paper and put it into the wet funnel
5. Pour some muddy seawater into the funnel
6. Carefully describe what you see to your group members What is in the funnel? What is in the beaker? How did this happen?
7. Is the water clean yet? Is it pure?
8. Pass the beaker on to the next group (Station 2), to put the liquid into the flask</td>
<td>Station 2
Distilling
Some broken bits of pottery have been added to the flask. The liquid in the flask is the same as that in beaker from Station 1
Discuss the following questions with your group:
1. What is happening in the flask?
2. What is going up the flask and then down the tube?
3. What is dropping into the beaker?
4. Why is the tube connected to the water tap?
5. How does the water in the beaker differ from the water in the flask?
Use what you know about the particle model of matter to explain what is happening in the:
6. Flask
7. Tube
8. Beaker</td>
<td>Station 3
Evaporating
This activity is dangerous, so be VERY careful
1. Put some of the liquid from the measuring cylinder into the little white bowl
2. Light the Bunsen and turn it down so there is a gentle flame
3. Add more liquid to the bowl as the liquid level drops
The liquid will sometimes ‘froth’. When that happens, move the Bunsen burner, let the ‘frothing’ die down and then put the burner back under the bowl
The first two groups on this Station will move on before the action is over
4. Keep adding liquid until it begins to ‘spit’. When this happens, turn off the gas to the Bunsen burner and let the bowl cool
5. Compare the liquid in the measuring cylinder with the liquid in the funnel and beaker on Station 1 and the flask and beaker in Station 2
6. What do you see in the bowl?
7. Discuss what you think is happening</td>
<td>• 250 mL beaker of mixed dirt and sand
• 3 large drinking glasses: 300–500 mL in capacity
• 2 × 1 litre bottles of sea water (60 g of table salt added to 1 L of water)
• 1 triple beam balance
• 5 clean beakers (250 mL)
• 3 tripods
• 1 wire gauze
• 1 pipe-clay triangle
• 2 Bunsen burners
• 1 ceramic evaporating dish
• 1 filter funnel
• 6 filter papers
• 1 distillation apparatus: round bottom flask, Liebig condenser, associated fittings and access to water tap and sink
• 1 measuring cylinder of seawater (100 mL)
• Small pieces of broken pottery</td>
</tr>
</table>

Reflection Activity:

- Imagine that you are washed up on a small tropical island with three of your classmates.
- Discuss with them how you might use what you have learnt through the activities in this lesson to produce safe drinking water.
- Design the equipment that you think that you might use from the things that might have been washed up with you.

Australian Curriculum Subject Outcomes and Descriptors

ACSSU113 **Separating mixtures**

Elaboration:

- Investigating and using a range of physical separation techniques such as filtration, decantation, evaporation, crystallisation, chromatography and distillation

ACSHE119 Scientific knowledge changes
ACSHE223 Science changes through collaboration

Elaboration:

- considering how water use and management relies on knowledge from different areas of science and involves the application of technology

- recognising that traditional and Western scientific knowledge can be used in combination to care for Country and Place

ACSIS125 Plan and conduct investigations

Elaboration:

- working collaboratively to decide how to approach an investigation, learning and applying specific skills and rules relating to the safe use of scientific equipment
- identifying whether the use of their own observations and experiments or the use of other research materials is appropriate for their investigation

Authentic Assessment

Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the ‘Reflection Activity’ stage. The teacher could monitor the quality of their discussions by moving between groups and enhancing the realism of the ‘castaway’ scenario by adding additional detail or asking open questions about the group response to their imagined situation. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through the class presentation of group plans.

Differentiation: This experiment can be duplicated with tank water, creek water, stagnant water, water from water holes and even tap water in order to try and gauge what pure water really is.

Investigate how people may purify water when travelling long distances without new supplies, when camping away from water supplies, in rural areas in times of drought etc. What equipment could they use to do this and what did the first settlers use to purify water?

Australian Curriculum Mathematics Outcomes and elaborations:

(ACMSP116)

(ACMSP117)

Numeracy Links

*List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions

**Recognise that probabilities range from 0 to 1

Australian Curriculum Subject outcomes and elaborations Separating mixtures **ACSSU113***Elaboration*: Investigating and using a range of physical separation techniques such as filtration, decantation, evaporation, crystallisation, chromatography and distillation **ACSHE119** Scientific knowledge changes **ACSHE223** Science changes through collaboration *Elaboration:* considering how water use and management relies on knowledge from different areas of science, and involves the application of technology, recognising that traditional and Western scientific knowledge can be used in combination to care for Country and Place **ACSIS125** Plan and conduct investigations. *Elaboration:* working collaboratively to decide how to approach an investigation, learning and applying specific skills and rules relating to the safe use of scientific equipment

The Learning Task: Year Seven- What is pure?

A laboratory based investigation of muddy sea water involving filtering, distilling and evaporating.

Including ATSI perspectives: These students belong to a cultural group who knew exactly how and where to find clean water in this dry land. The following shows how white are helped to find water by those who know all the traditional means http://www.rswa.org.au/publications/Journal/82(1)/82(1)bayly.pdf how to distil it without scientific equipment https://www.youtube.com/watch?v=s5G9nQTLB0U

Strategies to include learners with a background of oracy: many of these students are from cultures that were originally nomadic and who travelled to water in the dry seasons before the 1980s when the United Nations erected hand pumps. Not all settlements had these nearby so there was still some travel to collect water and may still have to be purified to the best standards possible. These student may know some of these methods

http://www.thealternative.in/lifestyle/traditional-water-purification-methods/

Authentic Assessment strategies:
Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. Questions may be:
Imagine that you are washed up on a small tropical island with three of your classmates.
Discuss with them how you might use what you have learnt through the activities in this lesson to produce safe drinking water.
Design the equipment that you think that you might use from the things that might have been washed up with you.
Do you think the volume of the water was the same in millilitres as when you started?
How probable do you think that your explanation for the events in Station 3 were on a scale of 0-1?

Variations for students from diverse social contexts: There are numerous reasons why students may not have consistent access to clean drinking water, although in Australian towns and cities the tap water supply is relatively safe to drink. http://www.cleverwater.com.au/blog/is-australia-s-tap-water-safe-for-drinking/4 In rural communities there may be concerns about the water supply so it is best to check your local area for information http://www.abc.net.au/news/2015-11-09/rural-children-at-risk-of-parasite-thriving-in-fresh-water/6922432http://www.health.nsw.gov.au/environment/water/Pages/drinking-water-database.aspx

Year 7: What is 'pure'?

250 mL beaker of mixed dirt and sand, three large drinking glasses: 300–500 mL in capacity, 2 × 1 litre bottles of sea water (60 g of table salt added to 1 L of water) one triple beam balance, five clean beakers (250 mL), three tripods, one wire gauze, one pipe-clay triangle, two Bunsen burners, one ceramic evaporating dish, one filter funnel, six filter papers, one distillation apparatus: round bottom flask, Liebig condenser, associated fittings and access to water tap and sink, one measuring cylinder of seawater (100 mL) and Small pieces of broken pottery.

Science Concepts:

Most natural materials are mixtures of different things. For example, sea water is a mixture of water, common table salt and small amounts of other salts. The different parts of a mixture have different particle sizes, boiling points, melting points, densities and solubilities. These are physical properties and we can use them to separate the different parts of a mixture. So we can dry out sea water to get the salt out of it. When we have tried all the ways of physical separation, what we have left is a pure substance. For example, if we cannot separate the salt any further, we have pure salt. This lesson applies this science to the problem of providing safe drinking water.

Lesson:

Activity Origin: Adapted from Brothers, Gow & Mackay 1977, p. 98.

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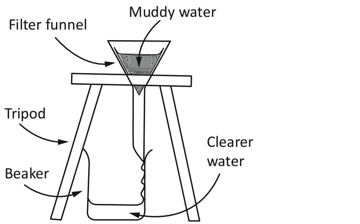
<td>
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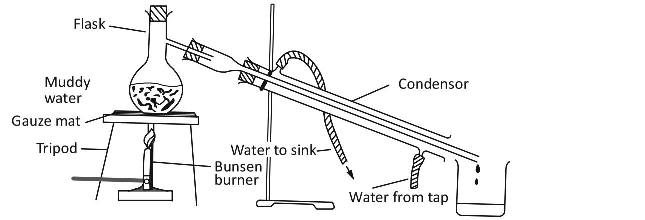
<td>
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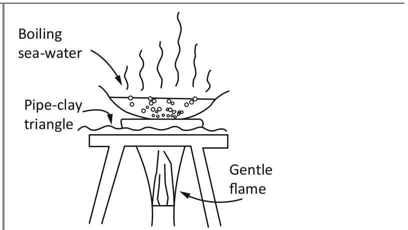
<td>
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</tr>
<tr>
<td>Station 1 Filtering
1. Put an empty beaker under the tripod
2. Wet the inside of the funnel with water.
3. Put the funnel into the tripod, so that its tube is inside the lip of the beaker
4. Fold a piece of filter paper and put it into the wet funnel
Pour some muddy seawater into the funnel
*,**Predict what may happen using fractions on a probability line 0–1
5. Carefully describe what you see to your group members. What is in the funnel? What is in the beaker? How did this happen?
6. Is the water clean yet? Is it pure?
7. Pass the beaker on to the next group (Station 2), to put the liquid into the flask</td>
<td>Station 2 Distilling
Some broken bits of pottery have been added to the flask. The liquid in the flask is the same as that in beaker from Station 1
Discuss the following questions with your group:
1. What is happening in the flask?
2. What is going up the flask and then down the tube?
3. What is dropping into the beaker?
4. Why is the tube connected to the water tap?
5. How does the water in the beaker differ from the water in the flask?
Use what you know about the particle model of matter to *,**predict on a probability line 0–1 what is happening in the:
6. Flask
7. Tube
8. Beaker</td>
<td>Station 3 Evaporating
This activity is dangerous, so be VERY careful
1. Put some of the liquid from the measuring cylinder into the little white bowl
2. Light the Bunsen and turn it down so there is a gentle flame
3. Add more liquid to the bowl as the liquid level drops
The liquid will sometimes 'froth'. When that happens, move the Bunsen burner, let the 'frothing' die down and then put the burner back under the bowl
The first two groups on this Station will move on before the action is over. *.
**Predict, using a probability line 0–1 what may happen as you add more liquid
4. Keep adding liquid until it begins to 'spit'. When this happens, turn off the gas to the Bunsen burner and let the bowl cool. Compare the liquid in the measuring cylinder with the liquid in the funnel and beaker on Station 1 and the flask and beaker in Station 2
5. What do you see in the bowl?
6. What do you think is happening?</td>
</tr>
</table>

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Technology Education and the Australian Curriculum

Deborah Trevallion and Maura Sellars

Introduction

Australia finally has its first national technology curriculum which is mandatory for all Australian children from foundation to year 8.

The Technologies area has two individual but connected compulsory subjects:

- **Digital Technologies**, where students use computational thinking and information systems to implement digital solutions. Computational thinking refers to problem-solving methods that involve integrating strategies, such as organising data logically, breaking down problems, interpreting patterns and implementing algorithms, all of which are integral to the mathematics curriculum teaching and learning.
- **Design and Technologies**, where students use critical thinking to create innovative solutions for authentic problems.

Digital Technologies

We are currently living a digital existence in a world of constant change; Society has evolved through a number of technological ages: the Stone Age, the Bronze Age, the Iron Age, the Steam Age, the Space Age and we now we inhabit the Information Age (Cowley, 2000). Here digital technology is an integral part of our

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lives and the internet has made the world smaller, producing a global village. Living in this digital age, in a world that is characterised by a digitised existence and constant change, it is critical that our children are empowered to manage this. They will need to have a deep understanding of information systems as this will enable them to use critical thinking when they manage data, interpret information, use processes and engage with digital systems to make decisions about their future. Digital systems support new ways of working in our global networks and require a new, essential skill set that includes computational and systems thinking.

The aim of the Digital Technologies syllabi is to ensure that all students can:

- create, manage and evaluate sustainable and innovative digital solutions.
- use computational thinking and the key concepts of abstraction to create digital solutions.
- use digital systems to automate and communicate the transformation of data.
- apply protocols and legal practices that support safe, ethical and respectful communications.
- apply systems thinking around information systems and predict the impact of these systems on individuals, societies, economies and environments (ACARA, 2013).

The amount of knowledge in the world is constantly on the increase, until the 1900s information doubled every century, by the end of World War II information was doubling every 25 years, today different types of knowledge, have different rates of growth but on average human knowledge is now doubling every 13 months and with the use of the internet, within the next seven years, this will lead to the doubling of knowledge every 12 h (Shilling, 2013). This vast expansion of information is occurring because as we develop additional instruments to encapsulate and distribute this knowledge, the quicker we are able to create more knowledge. With the increased amount of knowledge now available, we must develop ways to assist our students to validate, digest, analyse and interpret the information into understandings that can be further acted upon. The development of this skill set is heavily reliant on the capacities of students to use their mathematical concepts, processes, knowledge and reasoning as numeracy competencies.

Today's students use the internet to research and find data, teachers need to instruct students how to determine whether the resources they consume online are valid or not and to use this information to make it their own. We must develop autonomous learners who are critical thinkers that will cope in society faced with ongoing change and that requires sophisticated skills in finding patterns and relationships in the data that they generate themselves and in the data that is promoted by other sources. As it is now essential that students learn to think and reason independently, it has changed the teaching and learning dynamic for both students and teachers. Teachers can no longer provide a traditional knowledge-based approach to teaching, as students need to be empowered to manage this change. (Australian Education Council-Curriculum Change) For this to occur, the education curriculum has changed to an inquiry-based approach where the traditional teaching of information focus has been replaced by the teaching of the skills required to acquire and interpret information using a problem or inquiry-based approach where the students use and apply these skills in order to solve a dilemma that they have been given.

Students are often bombarded with new and fantastic gadgets that include iPods, iPhones, Android devices, tablets, iPads and now hybrid laptops. Many Australian children are exposed to one or more of these kinds of devices at any given time. These communication gadgets, including pedometers and other devices, can be a teacher's greatest tool for the lessons Elston (2013). Students are to be encouraged to use their own digital devices in the classroom in a bring your own device approach. Once the students' devices are connected to the network, a student can begin creating and self-teaching. Students will gain the ability to access any information that they require for their learning task. Through this, the teacher becomes a facilitator of learning rather than the authoritarian source. Students in classrooms taught by autonomy-supportive teachers, compared to students in classrooms taught by controlling teachers, experience an impressive and meaningful range of positive educational outcomes.

In 'Digital Technologies' there is a focus on teaching the students to code. The advantages of teaching students to create programming applications are numerous and especially supportive of the development of numeracy skills. When creating an application that can perform a task, such as a game or data collection, seeing it work is motivating, creating an excitement in the students that pushes them further into the world of digital exploration (Hall, Collier, Thomas, & Hilgers, 2005). Technology is used to support the teaching of numeracy.

Design and Technologies

The practical nature of the Design and Technologies syllabus engages students in critical and creative thinking, including understanding interrelationships in systems when solving complex problems. The aim of the Design and Technologies syllabus is to ensure that students can:

- document and communicate design ideas
- select and manipulate a range of ideas, tools, materials and techniques creatively, competently and safely in the development of designed solutions suitable for a range of technologies contexts
- explore, investigate, create and critique innovative, ethical and sustainable designed solutions using a range of technologies
- develop confidence as critical users and designers and producers of technologies and designed solutions
- understand the roles and responsibilities of designers, technologists and those in related occupations (ACARA, 2013).

The aim of design and technologies education is to develop creative and innovative thinking abilities as well as to develop students' social, cultural and environmental responsibility, as opposed to the conventional mastery of methods, techniques and an understanding of materials, processes and information systems through the application of concepts to problems, much of which is dependent on the logical thinking that students acquire through engaging authentically with mathematical concepts, including generalising and abstracting.

The Design and Technologies curriculum has changed from one that focused on skill-based learning to a holistic design-based curriculum that is intended to develop critical thinking and creative problem-solving skills for all. In the student-centred problem-solving approach, the focus is critical thinking and design. Students are expected to design, make, and evaluate. The process skills of mathematics are critical to the successful engagement of students with the design procedures. Students must have the fluent mathematical knowledge and understand when and where it is applicable. They must be able to effectively communicate mathematical design ideas and have the capacities to engage in the reflection, decision-making, evaluations and validations of their choices that constitutes adaptive reasoning.

Numeracy and Technology: Digital Technologies

The specific numeracy skills that are required for this comparatively new area of teaching and learning are articulated in the Australian curriculum (ACARA, 2012). Many of these basic mathematical skills associated with digital technologies focus on pattern and data production, presentation and interpretation. Students are also required to be able to manipulate numbers as algorithms in order to solve problems and to understand data in its various forms, including but not limited to the number. The data collected is represented in various ways, including technological representations, focussing on the usual visual organisers that are commonly used for number. These may include tables, plans, maps, etc. which are supplemented with other pertinent information in written form. Defining patterns, using software to develop representations and using algorithms to solve problems remain a focus of digital technologies continue into the middle years of primary schooling.

Variations to tables, developed from given data and criteria, known as 'branching' depend on logical decision-making for its successful completion. In the senior years of schooling, students investigate further than the base ten system and explore the digital number coding known as the binary system. Students are required to be able to represent base ten numbers in binary coding using indices and to explain how the binary system operates in digital technologies and robotics. They learn how to use their understanding of symbolic representations to design a digital system interface and how to design, modify and follow sets of algorithms using sequences, branching and repetition, and additionally, using user input. These sophisticated uses of digital systems facilitate student's skills in logically determining the sustainability and usefulness of digital systems in culture and society.

Numeracy and Technology: Design and Technologies

From the outset, the students in their first years of school are incorporating the ideas they have experimented with in mathematics learning, including the notions of push and pull, objects and movements both in the environment in general and in toys and products they use. They further explore the notions of force and movement and properties of some defined three-dimensional objects and materials. They engage in food production for healthy eating, using reasoning skills and those of measurement and relative and absolute quantities. They explore different elevations of objects in evaluating design; make two-dimensional drawings of objects and record data that is the result of fact gathering surveys and questionnaires. They check and evaluate their own constructions using the skills of adaptive reasoning to determine their decision-making, and in all of these activities, the students are required to understand the procedure and work with sequencing that is appropriate for their tasks.

These mathematical skills continue to underpin the learning as the student's progress through the learning in the middle stages of primary schooling and beyond. The investigation of forces and design, properties and construction using measurements, geometry, chance and predictions, whilst continuing to focus on motion and force, recording results and following sequence and procedures become increasingly complex and bound to the mathematical notions, concepts and skills upon which they are reliant. Students are required to engage with various types of mathematical visuals such as maps, diagrams, charts, graphs, grids, etc. both the communicate information they wish to share and to interpret information generated by others. They do this is in the context of recording or disseminating data as well as in making design representations. Models, plans, nets and diagrams that demonstrate their understanding of design and of the process of creating something new.

Conclusion

The teaching of digital technology in every classroom cannot be underestimated. Children now learn digital skills, without realising they are learning it as today it is not uncommon for a three-year-old child to have some basic knowledge regarding how to get on to the computer and load a game (Anderson, 2002). Students learn to use technology by doing and experiencing. If students are to move forward to be effective citizens in our ever-evolving society they need to be efficient users, interpreters and producers of information using digital technologies and the design process. It is important because it is one component of being a digital citizen—a person who is responsible for how they utilise technology to interact with the world around them, yet they cannot do that without significant competencies in numeracy as this underpins many of the ways in which students' experiences are facilitated in this learning domain.

Differentiation: This task can be completed with any fruit as the topic – really anything that grows locally with some success. Students can classify according to which plants have the most leaves, berries (blueberries grow in a pot if necessary). If there are trellises available, then a wide range of winter beans and peas can be grown if climate suits and grapes and other climbing summer edible plants can be grown in summer. Strawberries are a favourite

Australian Curriculum Mathematics Outcomes

(ACMNA001)

Numeracy Links

***E**stablish understanding of the language and processes of counting by naming numbers in sequences, initially to and from 20, moving from any starting point

Australian Curriculum Subject outcomes and elaborations:

Explore how plants and animals are grown for food, clothing and shelter and how food is selected and prepared for healthy eating(ACTDEK003)

The Learning Task Foundation: Planting and harvesting healthy foods

The students plant seeds, seedlings or plants that are more advanced in the school garden or in pots and nurture them to maturity before eating their produce.

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Including ATSI perspectives: The class can find pictures of native fruits and vegetables or be introduced to them by a member of the local community or parent. The class may like to grow native fruits or vegetables in their patch of garden or pot. While some of these are well known generally, it may be useful to look at http://www.mcd.com.au/our-

Strategies to include learners with oral backgrounds: many of these students have come from other climates and countries. They also may have native fruits that they identify from their traditional names. It may be useful fr the class to research the native fruits of their respective homelands and to put catalogue pictures of these and commonly bought or grown fruit on flash cards with the English names for their use. The students may engage with the songs and story about fruit from the video and can be encouraged to make their own oral story about the fruit they like. It may be hard to understand food choices and foods that other children will not eat or dislike. This is because having enough food may have been problematic in the past.

Authentic Assessment strategies:

Correct counting of the hand spaces between the plants, counting the plants, one to one correspondence

Variations for students from diverse social contexts: some students may not each fresh fruit, salad or vegetables for many reasons. Others may not have any opportunities to plant and grow owing to lack of garden space or lack of exposure to these fresh foods. It may be useful to take photographs of the garden as it grows. The students cab do this using iPads.

Technology: Foundation—Growing Healthy Foods

Resources: herbs, lettuce, tomato, strawberry seedlings for summer: bean pea, snow peas, etc. For winter growing or whatever is healthy and grows well in your area. Seedlings are best but seeds can thrive if cared for well but may need extra work thinning out and replanting. Enough planting materials so that each child has at least two items to plant in case of non-survival. A garden bed prepared for planting, paddle pop sticks or plastic spoons for digging and marking, gardening gloves or small sized disposable gloves for student use www.kitchengardenfoundation.org.au.

Introduction:
Australia has an obesity epidemic, especially in our children. Research on Australian children and obesity found that obese Australian children often do not like to eat vegetables which, when eaten regularly in appropriate amounts will prevent obesity in children. It has been found that children will eat vegetables if they grow them themselves.

Discussion: Questions may include:

- Who eats vegetables? Salad? Lots of fruit?
- Where does this all come from? (students may say the garden, supermarket, fruit shop, etc.)
- Do you know anyone with a garden?
- What do they grow?
- Do you eat these?
- Do anyone have a garden at home where they grow things to eat?

Task: Tell the students that they are going to plant some vegetables/fruit, etc. in their school garden.

- Give out the paddle pop sticks or plastic spoons (two per child) and ask students to write their names on them with a marker (or if preferred, the teacher can do this with a permanent marker).
- Practice the digging motion safely so the students know how to dig without having the soil in their neighbour's face.
- Practice the tamping down of the soil gently to secure the plant in the earth.
- Go to the garden and line students up with their gloves, spoons or sticks and their plants.
- They dig a hole large enough for the plant, plant it, tamp it down and put their named stick or spoon in the soil beside it.
- Use hand spaces to separate the plants, less for small plants, more for plants that will grow larger.
- Do the same for the next plant or seed.
- Have spares of plants, seeds and sticks or spoons in case of misadventure!
- Water carefully and *count the number of plants that have been planted.

The Learning Task Year Two – Developing a data base

Students need to design questionnaires, conduct the survey and then enter information into a database for the purpose of finding out more about their classmates

Differentiation: This task can be differentiated in many ways. The students can design questions to interview practically anyone selected about anything that need to the know about. The key to students writing interview questions is to keep focussed on what is useful information. This is an analytical task- deciding what is useful and what is superfluous information.

Australian Curriculum Mathematics Outcomes

(ACMSP048)

Numeracy Links

*Identify a question of interest based on one categorical variable.

**Gather data relevant to the question

Australian Curriculum Subject outcomes and elaborations:

Recognise and explore digital systems (hardware and software components) for a purpose (ACTDIK001) playing with and using different digital systems for transferring and capturing data,

Including ATSI perspectives: while this activity is not intended to marginalise, to stereotype or in any way position students in an uncomfortable space, it would be wise to check the questions created by all students irrespective of the student's own background or that of the persons to be interviewed. Some groups of ATSI students and others are uncomfortable with direct questioning, so it is important to ascertain if simply asking – tell me what you like? Tell me about you? Is more appropriate and respectful in your context than a questionnaire.

Strategies to include learners with oral backgrounds: depending on their experiences, some of these students may shock their peers with their stories. They may also find it distressing to talk about themselves or they may nominate their favourite hobbies or sports as other than the usual responses expected from students of this age. They may also try hard to be the same as everyone else and to fit in, despite their real preferences and skills. This activity may need to be thought through in your specific context to determine how exactly these students can be included without compromising them.

Authentic Assessment strategies:

Are students able to develop a short, focussed questionnaire? If appropriate)

Are students able to sort and able information and enter into a data base?

Are students able to find the common ideas and group students appropriately?

Variations for students from diverse social contexts:. As indicated in the ATSI perspectives, respect for difference and the celebration of diversity must be established as the genuine culture of the classroom before this task could be attempted. Different cultural and social perspectives around what is acceptable behaviour and conduct for children and students must be considered. Every child is entitled to their story, their identity and their preferences. Some students with diagnosed disorders may find it very confronting and challenging to be part of this activity and so it would need to be implemented with care and with the students themselves a primary consideration.

- Back in the classroom; make a calendar showing who is watering on each week day with their school buddy. Rainy days can be coloured in blue.
- When the plants are ready, harvest and eat in class or take home carefully in a brown paper bag.

Technology: Year Two—Digital Technology and Data Base

Resources: Class set iPads. Laminated name labels: three for each child in the class.

Introduction:

Design: Your class has fragmented friendship groups and a number of students who are new to the school have been placed in your class this year. To unify the students and build respect between the various cultural groups in your class you need to build friendship bonds and respect between students.

Discuss:

- What is a data base?
- Why do we need a data base of our class to share information?
- What type of information can students share with their peers?
- List possible questions.
- Can we include images and edited video clips?
- How many pages can be allocated to each students?
- How should each student present their information to the class?

Task 1: *design a set of six questions you want to ask three people in your class to determine what they like to do in their spare time, which hobbies they have, which sports they play, which foods they like and anything else you can think may be interesting to know as a friend. Dip into the bag of names and pull three out. (if you get the same name twice, hand it to the teacher and pick out another. The teacher can then replace the duplicate in the bag.

Task 2: *interview your three students using your self-designed questions.

Task 3: **In groups of three, the students are to create a data base on the other students they have interviewed in the classroom. Each group's data base will be put together with the rest of the class in order to share common interests and activities and familial difference.

Task 4: Plan activities that include all the students with similar interests or preferences.

Differentiation: This task can be differentiated in many ways. The students can select a healthy lunch and see if their parents or caregivers are able to make it for them to try. The students can also change some of the ingredients without compromising the healthy nature of the food.

Australian Curriculum Mathematics Outcomes

(ACMSP068)

Numeracy Links

*Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording

**refine questions and plan investigations that involve collecting data, and carrying out the investigation

Australian Curriculum Subject outcomes and elaborations:
Investigate food and fibre production and food technologies used in modern and traditional societies (ACTDEK012) - recognizing the benefits food technologies provide for health nd food safety and ensuring that a wide variety of food is available and can be prepared for healthy eating

The Learning Task Year Three – A Healthy Canteen Menu

Students are required to design a healthy menu for the canteen by researching healthy canteen food on the iPads and then surveying their classmates to establish its popularity.

Including ATSI perspectives: This may be a genuine opportunity to introduce students to some traditional fruit or vegetables and incorporate these into the canteen menu with the advice of a community member or parent. The class can learn how they could find or grow these and how to prepare them for inclusion in the canteen menu

Strategies to include learners with oral backgrounds:

The class may wish to research food from their original homeland and include a healthy item in their menus or collect catalogue pictures of these foods and label them for future reference. A parent or community member may bring in some of these foods so students can develop some cross cultural knowledge and sensitivities.

Authentic Assessment strategies:

Are students able to select healthy foods for both savoury and sweet dishes that are suitable for the canteen?

Are the students able to conduct a survey and interpret the results of the data?

Are the students able to select a well -balanced, healthy menu for the most popular menu?

Variations for students from diverse social contexts:.

Some students do not have a lot of experience of healthy eating and so they may need more support and guidance than others with their choices of menu. This can be an opportunity to investigate the different healthy foods that are important to different groups of people. Some of these may be a matter of personal taste. However, all groups should be represented and respected for their healthy food choices, even if they are not to the taste of some students (seaweed, sushi, Chinese dessert, Indian sweets etc.)

Technology: Year Three—A Healthy Canteen Menu

Resources: iPads, http://healthy-kids.com.au/school-canteens/canteen-recipes/, http://www.schools.nsw.edu.au/studentsupport/studentwellbeing/schoolcanteen/recipes.php, http://www.nutritionaustralia.org/act/school-canteen-recipes, http://www.education.vic.gov.au/Documents/school/principals/management/gfylman.pdf, http://www.freshforkids.com.au/canteen_fresh/canteen_fresh.html

Introduction:

The school healthy canteen was flooded in the latest downpour and cannot reopen for a week. Upon reopening the newly refurbished canteen hopes to have a new healthy menu to go with its healthy look. Create a menu of new exciting healthy food to be sold at the canteen. The food items must be healthy, sweet and savoury, quickly manufactured, tasty and most importantly, the children must like it.

Discuss:

The key terms: healthy, sweet, savoury and manufactured.

Select the most suitable websites to upload on the iPads and set the students the task in pairs, or small groups (may also be an individual task).

Task: Design the menus so that you have a different menu for at least three days of the week.

- On the menus, you should have two choices of sweet and three choices of savoury for each day.
- You should indicate what is in the food so that you can be sure it is healthy.
- When your menu is complete, *survey your classmates to establish what other students like to eat.
- Depending on the data collected, **revise your menu or leave it as it is for the final version.
- Share all the menus with each other.
- Using tallying, vote for the most popular menu.
- Perhaps this could be suggested to the canteen organisers as a menu for a special day or perhaps a regular day of the week once a fortnight/month/week.
- Or suggest to the canteen organisers that they have a nominated day to provide the winning menu and **then you can collect data from the whole school about its suitability and if the students liked it or not.

Differentiation: this is a differentiated task as it allows students to identify problematic areas as they see them, design solutions in their own way and create a model for the solution to the problem.

Australian Curriculum Mathematics Outcomes

(ACMMG063)

Numeracy Links

*Make models of three-dimensional objects and describe key features

Australian Curriculum Subject outcomes and elaborations: Critique needs or opportunities for designing and explore and test a variety of materials, components, tools and equipment and the techniques needed to produce designed solutions (ACTDEP014)

The Learning Task Year Four – Increasing Classroom Functionality

This task requires students to problem solve solutions to the classroom environmental problems, devise a plan or design for solving these, construct the model or full size solution and present their work using digital technology

Including ATSI perspectives: Typically, these students can be very creative and may be adept at using materials to solve problems of a practical nature. They will be able to contribute another perspective to the solutions as many of them would prefer to be learning in an outdoor environment even if they are living in urban settings.

Strategies to include learners with oral backgrounds:

These students may have had experience with problem solving and may be very creative or they may have had to survive in much worse environments and may not be forthcoming in critiquing the classroom environment. Many may prefer outdoor settings in which to learn

Authentic Assessment strategies:

Can the students identify problems in the classroom environment?

Can they design and make a satisfactory solution for their selected problem?

Can they share their work effectively accompanied by a comprehensive Nearpod presentation?

Variations for students from diverse social contexts:.

Many students have cultural or social embargos on criticising anything that is associated with authority, teachers and teaching so may not be comfortable with this task initially. For other students, the classroom may be the safe place they experience and they may also be reluctant to be critical. The key to involving everyone is to focus on the everyday, small problems that are annoying and fixable – perhaps that just need a fresh perspective and students can engage in fun solutions as well as the practical designs.

Technology: Year Four—Increasing Classroom Functionality

Resources: Variety of model making materials including paddle pop sticks, craft glue, cardboard, etc. and other items that the students may use to make their products from the design drawings.

Introduction:

Design: The classroom has many spaces that require improvements to increase its functionality. The students are to examine the classroom and list physical things that could be improved, made easier, designed better. The students will list problems like reaching books on the top shelf, getting out resources from the bottom of the cupboard, the door slamming shut on a windy day, storing the cleaning cloth so it dries and does not go smelly after art class, storing artworks so they are not dog-eared. These problems are then listed on the smartboard and the students in small groups nominate the one that they will solve using the design process. They may create models if it is not possible to make full-size systems.

Discuss:

- How can we make our classroom more practical for all of us to use?
- What are the problems we have experienced with the environment in here?
- How could we improve our environment so that we minimise these problems?

List the classroom problems and difficult spaces or even lack of functional space or equipment.

In groups/pairs/individually students select a problem/area to focus on

Task: *Design new equipment to solve the problem or redesign the classroom space on paper, then make a model. Develop a presentation using Nearpod and share your work with the class/school or at a parent evening. Develop a set of questions for your audience to respond to using Nearpod.

Technology: Year Five—Water Saving and Partner Planting

Resources: plant pots and soil, disposable masks for students, garden gloves or disposable gloves for students, large jars (one for each student) plants (both vegetables and flowers) activated charcoal, small rocks http://www.lifestyle.com.au/gardening/how-to-make-a-selfwatering-vegie-bed.aspx, https://www.youtube.com/watch?v=d-YjrhzKE6I, http://inhabitat.com/diy-how-to-make-your-own-green-terrarium-to-keep-or-give-away-for-the-holidays/, http://

Differentiation: There are many ways to differentiate this lesson. There are opportunities for students to select their plants and to work with design as they understand it.

Australian Curriculum Mathematics Outcomes

(ACMMG108)

Numeracy Links

*Choose appropriate units of measurement for length, area, volume, capacity and mass

**recognize that some units of measurement are better suited for some tasks than others

Australian Curriculum Subject outcomes and elaborations: Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions(ACTDEP026) working safely, responsibly and cooperatively to ensure safe work areas,

The Learning Task Year Five – Water saving and Partner Planting

The students design and make self -watering pots and terrariums and grow a selection of herbs, vegetables and flowers that thrive together and deter pest such as aphids and snails

Including ATSI perspectives: Although many of the bush tucker foods are familiar to almost everyone now, v some actually being grown as commercial crops, it is important to include the suggestions that these students others in the class offer about native plants that ae edibl and traditionally included in the diet, and are water savir actually water providers in times of drought. Depending the context, these and other students of similar backgrou may be the experts.http://www.mbantua.com.au/bush-tucker/bush-tucker/bush-tucker/bush-tucker/

Strategies to include learners with oral backgrounds: Many of the students in this group may have originated from hot, dry lands and know the value of water. This is really useful task for this group of students as they are not entirely reliant on language to engage with the task, they can observe the other students at work. It is an interactive task so they can work with others who may be able to familiarise them with local plants and herbs and others that thrive in your location. This may also be an opportunity for the class to develop waster saving strategies, including those used traditionally by these people in their original homeland.

Authentic Assessment strategies:

Are the designs practical and do they work?

Are the selected plants appropriate growing partners?

Are the pest repellent plants included in the selection?

Can students explain what they have done to make their products and why they work well?

Variations for students from diverse social contexts:

This is a useful task for all students as it requires students to be active and to engage creatively with quite a sophisticated concept of plants recycling water and self -watering. The resultant products can easily be taken home and the students can replicate the product readily at home, irrespective of the size of their grden or even the lack of a garden.

www.mnn.com/your-home/organic-farming-gardening/stories/12-plants-that-repel-unwanted-insects, https://en.wikipedia.org/wiki/List_of_pest-repelling_plants.

Introduction:
Discuss: Australia is a dry hot country with a shortage of water. Your family has decided that they want to decorate an area of their home with potted plants. This could be an indoor or outdoor area using terrariums, pots or self-watering systems. The plants could include a food, herb or flower garden or a combination that work together for a purpose, e.g. Marigold flowers planted with lettuce help to keep the snails away. Being a green (eco-friendly) family they have decided to use recycled containers (that you will decorate) for the pots and plants that do not require large amounts of water. Questions may include the following:

- What do we need to know about the plants? (if they need lots of water, are they more useful planted with others? Which ones could keep the pests away?, etc.)
- How do terrariums work to save water?
- Have you seen a self-watering system or self-watering pots?
- How could we find out what we want to know?
- *What sorts of measures would you need to use to (i) design and build a terrarium or other structure that you have designed?
- **What different measures are suitable for (i) different attributes that you are working with (for example, length, mass, capacity, temperature, volume, etc.) (ii) the scale or amount of these attributes?

In small groups the students investigate the areas of that they are interested in or the information they will need to find out to make (i) as self-watering unit for vegetables or herbs (ii) a terrarium (ii) a selection of plants that grow well together and (iv) can repel snails and other pests.

Task:
When students have a clear idea of the basic structures they have to work with, what they have to do and have assembled the extra plants or materials from home that they would like to use, they design and make their self-watering planters and their terrariums.

Technology: Year Six—Designing an Interactive Game

Resources: cardboard, Lego or other construction equipment for the moving parts, glue, string, small springs, small containers for water, fasteners and other materials depending on the student projects that are planned https://www.pinterest.com/miacari/homemade-kid-games-educational-fun/.

Differentiation: There are many ways to differentiate this task. The following components may be altered

- The type and number of moving parts required
- The overall size of the game
- The purpose of the game
- Design of the game overall can be made more complex or simpler

Australian Curriculum Mathematics Outcomes

(ACMMG141)

Numeracy Links

* Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles.

** Use results to find unknown angles.

*** Solve problems involving the comparison of lengths and areas using appropriate units

Australian Curriculum Subject outcomes and elaborations: Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions(ACTDEP026) working safely, responsibly and cooperatively to ensure safe work areas,

The Learning Task Year Six – Interactive Game Creation

The students have to create a game to specifications, which include creating at least three of the nominated moving parts and remaining within the limit of the given dimensions

Including ATSI perspectives: Games were traditionally played by everyone but not necessarily at the same time. Some games were played by men and boys only. The class may like to base their game on traditional Aboriginal or Torres Strait islander games and may invite a member of the community or a parent to talk about the traditional games as they know them.

http://www.creativespirits.info/aboriginalculture/sport/traditional-aboriginal-games-activities#toc1

Strategies to include learners with oral backgrounds:

Like other cultural groups, these students come from tribes with diverse traditions and characteristics. The class and students in this group could search to find information about traditional childhood games that would have been played by their parents and grandparents. They may like to adapt one of these to make their interactive game.

http://www.goss.org/index.php/about-south-sudan/games-sports

http://www.africa.com/blog/the_top_5_african_games/

Authentic Assessment strategies:

Are the designs practical and do they work?

Are the moving parts sturdy and usable?

Have the designs satisfied all the criteria?

Can students explain what they have done to make their products and why they work well?

Variations for students from diverse social contexts: In many western cultures, the choice of sports games played by adults may be indicative of their social backgrounds. However, many of the games that were played traditionally before the widespread use of digital technologies were common to many peoples. Some families have games they play traditionally at certain times of the year, especially at celebrations. Students may like to develop their games in the family or community context. Some parents or community member may like to come and talk to the class about the traditional games that they played

Http://www.topics-mag.com/edition11/games-section.htm

http://www.gameskidsplay.net/games/foreign_indexes/

Design: The world of games is always looking for new and innovative games to play. An old favourite is a game called Mousetrap which uses many moving parts. You are to select a theme and create, manufacture and evaluate a game with three or more moving parts chosen from a pulley system, a weight-bearing bridge, a slope greater than 20′, a spring-loaded mechanism or a water/wave component. The game may be no larger than $50 \times 50 \times 50$ cm

Discussion: Questions may include:

- What is an interactive game?
- How might you organise moving parts?
- *Do the angles at which the moving parts connect/move away from with other parts of the interactive game have any bearing on the movement?
- **How could you identify the angles at which the other parts meet the moving parts from the measurement of the angle required for the moving part to move effectively?
- **What might happen to the moving parts if the angles at which they are attached are too wide or too narrow?
- ***How would this impact on your design?
- What types of themes do you think would appeal to the age of the child you are designing for?
- What may be too complex/simplistic for that age of the child?
- What considerations do you think may be important?

Task: Design, making a plan on paper and then construct the game keeping in mind the criteria above.

Identify:

- Theme
- How many players are optimal.
- The age group the game is designed for

Students may bring in items from home to complete their game.

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Visual Art, Visual Design and Numeracy

Kathryn Grushka and Nicole Curtis

Introduction

The history of the arts and the design world is underpinned by the world of proportion, ratio and measurement, abstract concepts that inform the construction and design of objects in the material world. To be a mathematician or an artist/designer requires the development of spatial reasoning (Gero, 2015) and an understanding of how we can represent and communicate this knowledge through visual symbolic systems. Artist/designers work with images and other visual systems, such as three-dimensional models, as their cognitive tools, and this diagrammatic knowledge can both reflect and affect thought. Learning in visual art and design is generated through the active construction of ideas to images and models (Nickerson et al., 2013). As heuristic sketches are refined in meaning-making, the connection to numbers is developed. Visual coding, along with verbal and analogue quantity coding, is essential in advanced maths tasks (Kroesbergen, van't Noordende, & Kolkman, 2014) and the development of spatial abilities and visual imagery or visuospatial reasoning is essential. Owens (2014) further emphasises the development of visuospatial reasoning in problem-solving and how it connects to other cognitive processes, heuristics and affect. The application of numbers underpins the visual design world and is developed through reflective decoding, analysing and knowing how imaging work can be refined through number (translating a concept sketch to a scale model for example), and subsequently applying or connecting this knowledge and its related spatial and number skills into a range of design contexts when making new meaning.

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It is important at this point to reflect on how learning theory, neuroscience and the cognitive sciences are increasingly informing educationalists of the central role or work of images in reasoning. Tversky (2015) clearly identifies the importance of sketching or working with images as both diagrams and gestural acts (found in geometry, visual art and design). Images are used to augment the mind; they can be referred to as diagrams, sketches, graphics, models, cognitive artefacts, maps or cognitive tools. The world of art can trace how both art and science are filled with culturally and historically evolved visual tools. In the visual design world, we would look at diagrams, 3-D models, artworks, sculptures or graphic design as the qualitative application of spatial-relational reasoning (Egenhofer, 2015). Furthermore, cognition and memory are not phenomena that can be isolated from affect and the social context (Duncan & Barrett, 2007; Immordino-Yang & Damasio, 2007; Sah, 2013). Learning involves the construction of meaning from an external focus that is then internally processed delete and memory. Memory involves both the recall of content and context associated with our accompanying sensory and motor experiences (Damasio, 2012). We learn and remember best when one or more sensory systems are at play. Learning is strongest when two or more modes of experiences are combined (Moreno & Mayer, 2007). In this chapter, it is important to understand that visual designing is a multimodal experience; it combines the mind, the hands and the eyes. In visual design, we manipulate materials and forms (models), and we represent them as spatial knowledge, abstract ideas in combination with our other senses such as touch/feel. We augment this knowledge through other literacy forms to refine our conceptual ideas. To do this we combine images, words and numbers. As you read this chapter, it is important to note that many of the words used to describe measurement, geometry and number concepts carry simpler or the same meanings in visual art and design. Knowledge is distilled from sensory experiences and is coded and stored for future recall.

The application of number in visual art/design learning involves observing, analysing, measuring, counting and considering relationships between numbers, shapes, forms and rhythms in order to gain spatial harmony and balance when making design works. The very beauty of our constructed world has evolved from the investigation of the rules of number underpinning nature and most design endeavours (Hemenway, 2008; Pickover, 2009). The journey to this understanding for all students involves observing the macro or the micro worlds of the earth and the universe. It involves discovering their numerical secrets and then applying them to one's own design problems and problem-solving processes that emerge from a social, cultural or personal need.

To illustrate the richness of the content for teaching and learning across all ages in visual art/design, this chapter will provide two examples from the visual design world to consider. One is located in the world of the built environment and architectural design that draws on the spatial and structural understandings historically linked to sculpture or 3-D representation. The other is in two-dimensional (2-D) visual design or graphics and focuses on scale, proportion, pattern, sequencing and fabric construction or weaving. It will consider how these examples can be taught and applied separately and in combination.

To introduce the world of graphic design (surface design), architectural design or spatial reasoning using models or surfaces, we simply have to look to the shapes, proportions and patterns in organic structures in nature such as the snowflake and soap bubble, or the constructed forms of the spider web, beehive or bird's nests to see how they have been mathematically interrogated, rules discovered and principles applied. Take the time to consider the works of Bosse (2013), who designed the Water Cube for the Beijing Olympic Games based on bubbles, or the work of Buckminster Fuller on geodesic dome structures (Fuller, 2008, 2013). You may also consider looking at the umbrellas, domes and tents created by the architect Frie Otto, who works with structural mathematics (Otto, 2013). Or study the ancient cultural legacy of the structures of the yurt or ger (Kernery, 2006), the Japanese art of origami (Lang, 2011) and its geometric three-dimensional shapes and forms, or examine the cultural complexity of textile art and design, the 3-D dimensional world of weaving that crosses both the construction of forms (baskets) to tapestry or rug design, and moves into the mathematical and structural world of Jacquard (loom) weaving in industry.

So let us now consider how the world of spaces, shapes, structures and patterns coexist with the world of numbers, counting sequencing, measuring, calculating spaces and applying the rules of ratio and proportion. We can do this by observing, analysing, recording and applying the natural patterns or organisational structures found in nature or in manmade cultural and contemporary visual design objects. Thinking in numbers penetrates into our unconscious everyday life and lies at the heart of art/design works. Through the examination and making of visual design objects, and the conscious articulation of spatial thinking in artmaking processes, teachers can begin to unlock our understanding of numeracy as a hidden code in the arts. The linking of words, number and visual thinking processes is not often articulated or connected as interdisciplinary thinking by classroom teachers to their students.

Perspectives of Teaching and Learning in Visual Design

Visual Arts, including visual design, empowers students to engage in visual forms of communication, exploring the visual language found all around them in their social, cultural and technological worlds. Students respond to these influences by talking about, writing about and calculating with a number when making individual and collaborative art/design work. It values individual experimentation and problem-solving while encouraging students to use their imaginations. Concrete and abstract ideas are explored through either the manipulation of 2-D or 3-D thinking processes or the selection of materials and forms. The arts also foster reasoning that encourages the following: the organisation of ideas from a range of sources, such as the natural world and the manmade world of objects and structures; and spatial reasoning, the application of the elements and principles of visual art and the strategic ability to organise, reflect, modify and evaluate their visual representations when solving problems. The following knowledge and skills drawn from the Australian Curriculum and Reporting Authority [ACARA] curriculum The Arts (Visual Arts), currently viewed as a working draft.

Inquiry Skills

Observe, sketch, explore and record: In the arts, teaching this process requires an open-mindedness to what the students are actually observing as individuals and a willingness to consider that the object of study can be viewed from multiple perspectives. Teaching the skill of observation and focus is the foundation of all learning (McConville, 2011).

What does this mean for you as a teacher of numeracy?

- You will have to be open to offering multiple viewpoints, or ways of seeing and understanding the world of visual design in 2D and 3D forms.
- You will want to seek out many different natural, historical, contemporary and cultural examples as sources of ideas to inform visual design principles being applied to the material world.
- You will need to help the student observe, sketch, explore and organise their examples as they are informed by the world of numeracy.
- You will need to identify the common language used in the teaching of numeracy and visual design. There is an extensive list of concepts in this area. Examples include the language of geometry shapes: circles, triangles, rectangles, cylinders; and measurement: volume, area, angles, solids, liquids.
- You will be required to support students in looking for how the elements of visual design, such as line, colour, shape, space, form, and texture, are used to describe and represent the principles of visual design such as patterns, sequences, proportion, rhythm, and movement.
- It will be necessary for you to provide opportunities for students to explore and explain how an understanding of these principles involves counting, measuring, estimating and calculating, and how the application of number concepts, sequencing and patterning is informed by the qualities, shapes and spaces of materials in visual design forms.

Experimentation with patterns, shapes, forms: In the visual arts, this will require experimentation across the three forms: two-dimensional (2-D) form, three-dimensional (3-D) form and four-dimensional (4-D) time. There will be a strong expectation on the teacher to offer many and varied ways to interrogate the objects of study by offering a wide range of materials, as well as forming and joining techniques when measuring and experimenting with patterns, sequences, shapes, forms. This provides students with the widest possible variety of opportunities to engage with visual design. These opportunities will include the traditional expressive forms of painting, drawing, and printmaking, but also extend to sculpture, construction and technological imaging environments such as digital photography and digital animation, which includes the additional modes of sound and movement. When using a variety of forms, the teacher can extend the students' experimentation to include many ways of representing and applying numeracy concepts, such as repetition, scale and proportion when solving problems of perspective. These include, but are not limited to, size, geometric qualities of shapes and forms, counting numbers of planes, measuring angles and differentiating between the qualities of organic or inorganic shapes and forms. The students' tasks in all of these include uncovering the principles of proportion, scale, space and structure when refining ideas and creating solutions.

When you offer learning opportunities in all of the dimensions of the visual arts (2-D, 3-D and 4-D), you immediately begin to open up the world of spatial learning and its interdisciplinary applications, STEM/STEAM education (Montello, Grossner, & Janelle, 2014). Working with shapes, scale, proportion and ratio, when applied to patterns and structures, reveals relationships between spatial learning and number (Knott, 2010). This then finds students encountering the extended application of the concepts and principles to include procedures, strategies and adaptive reasoning as they work productively to organise ideas to solve problems and refine solutions. It finds them beginning to manipulate, modify and evaluate as they aim, through the application of spatial reasoning and numeracy, towards discovering tried and original conclusions or solutions in the practical world of visual design. They then apply these to the specific social and cultural inquiry they have selected to investigate in visual design.

There will be a strong expectation in the forthcoming document that opportunities for observation and experimentation will be extended by the teacher. It also requires the teacher to be mindful of play and imagination in opening up creative opportunities for the students. Scale, proportion, ratio and harmony as concepts of aesthetic and mathematical beauty are applied to surface design, graphic design, architecture or object design. By providing opportunities for the students to see the object of their observation, from different angles and in different contexts, you will be widening their understanding of numeracy application in visual design thinking.

Extending Visual Design and Spatial Thinking

To begin to design learning experiences and explore the rich and diverse world of visual design, a teacher simply needs to follow in the footsteps of past explorers who came to understand numbers and their relationship between the natural and manmade world by drawing, constructing, measuring and working with pattern and proportion. We then need to provide students with the opportunities to apply inquiry skills to their own visual design problems and explorations. The skeleton tasks below are arranged so that, at any stage, tasks can be differentiated in order to match students' levels of skill and understanding. The skills are arranged in a continuum so that teachers can easily plan and assess individual student's levels of capacity in any aspect of the design process that is detailed in the (*forthcoming*) Australian Curriculum: Visual Arts (ACARA, 2013), irrespective of the students' ages or stages of schooling. The numeracy general capability indicates the need for cross-curriculum commitment when implementing mathematical knowledge and skills (ACARA, 2015, 'General Capabilities'). Once the teacher engages with the visual design processes and its related concepts, words and thinking, the richness and complexity of numeracy applications for designing can be incorporated.

Mathematical codes or rules underpin the world of nature, science, art and design. Firstly there is the Golden Mean (Knott, 2010), which underpins our unconscious aesthetic appreciation of the world of natural objects and physical phenomena, as well as the design of all manmade objects. This rule is powerfully connected to our feelings of harmony and balance. Secondly, there is perspective and spatial awareness, which is informed through the practical application of shapes, scale and the location of objects as they operate in space. This space can be seen as either 2-D, 3-D or 4-D (time), and we have developed grid structures or systems to support our visual representations of the world. These grid structures operate either visibly or invisibly in art and design works. This can best be illustrated by considering how artists and architects use grid structures and measurement to change the scale of objects. Or consider the world of animation, as animators work with grids to build virtual worlds that objects move through. When designing teaching and learning activities, it will be necessary to consider these codes and rules as they inform 2-D, 3-D and 4-D artworks.

Conclusion

This chapter has presented how the world of mathematical concepts and ideas is directly related to spatial reasoning as it applies to the national curriculum for visual arts. The strand of visual art and design was selected, but the codes and conceptual underpinnings of all strands of visual arts have the potential to foster, promote and scaffold deep mathematical understanding through engagement with experiential learning. Activities such as those detailed in Section "Perspectives of Teaching and Learning in Visual Design" are skeleton activities and are provided as sample highlights of the possibilities of how to support students' learning in numeracy whilst they experience learning in the visual arts. The extrapolation of the activities that focus on the circle serves to illustrate exactly how this learning in numeracy could be achieved, whilst leaving the actual implementation to individual teachers. Teachers are at liberty to implement the activities in the contexts of their individual pedagogical preferences, using the strategies that illustrate best practice for their own groups of students and within the circumstances and limitations of their resources and support systems. The praxis approach serves not only to engage students' relative strengths to support learning in numeracy, but it also provides opportunities to develop critical and creative thinking, which can then be utilised as 'robust' conceptual strategies and knowledge that can be transferred to other learning contexts and situations.

(Lessons plans supporting this chapter have been also included and have been trialled in a school setting).

Differentiation

After initial whole class discussion students are encouraged to explore and investigate the mathematical aspects of the artwork in a variety of ways, allowing differentiation for ability levels as well as areas of interest and need.

Students are given the opportunity to investigate different shapes depending on their ability levels as well as different sized arrays.

Australian Curriculum Mathematics Outcomes: Numeracy Links

The proficiency strands **understanding (U), fluency (F), problem solving (PS)** and **reasoning (R)** are an integral part of mathematics content across the three content strands.

Shape: *Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features (ACMMG022)
Describe and draw two-dimensional shapes, with and without digital technologies (ACMMG042)

Patterns and Algebra: **Investigate and describe number patterns formed by skip-counting and patterns with objects (ACMNA018)
Recognise and represent multiplication as repeated addition, groups and arrays (ACMNA031)

Australian Curriculum Creative and Practical Arts outcomes:

Explore ideas, experiences, observations and imagination to create visual artworks and design, including considering ideas in artworks by Aboriginal and Torres Strait Islander artists (ACAVAM106)

Use and experiment with different materials, techniques, technologies and processes to make artworks (ACAVAM107)

Stage 1 Learning Task 1

A mathematical investigation of Kandinsky's "Squares with Several Concentric Circles" (1913).

ATSI considerations

Aboriginal 8 Ways of Knowing References:
Deconstruct - Reconstruct
Non-Verbal
Symbols and Images

http://8ways.wikispaces.com/8way+maths

Strategies to support learners with oral backgrounds

Students may engage more effectively with the learning tasks if they are developed in terms of a narrative, placed in social contexts and the key words repeated and integrated in the interactions between teacher and student and student and student. Actions and physical activities can enhance conceptual understandings.

Authentic Assessment strategies

Students self assess the results of their work and their learning. A cloze sample can be found on the facing page.

Students' understanding is determined used by the language used when describing the artwork, through questioning as well as their reconstruction of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Stage 1 Numeracy and Visual Art: Lessons One, Kandinsky's 1913 'Squares with Several Concentric Circles'

Resources Large-scale image of Kandinsky's circles, A3 whole class mathematics journal, counters, chalk pastels, oil pastels, paints, camera or digital device.

Introduction
Students observe, analyse and discuss what they see in the artwork. Guiding questions may include:

*Can you describe the lines you can see? *(U)*
*Can you describe the shapes you can see? *(U)*
*Could this painting be created using other shapes? How? *(PS)*
*Is there a quick way of counting the equal rows? **(PS)*
*Could you make a similar pattern using more in each row? ***
*Could you make a similar pattern using less in each row? **(PS) (R)*
*How many groups of circles do you have? **(F)*
*Will it always make a large rectangle? ***(PS)*
*Is there a way of making the rows into a different shape, other than a rectangle? ***(PS) (R)*

Discussion
Mathematical terms used when discussing the work can be listed in view of students in the whole class mathematics journal. This journal may be referred to at the beginning or end of each lesson. It can be used to reflect and record the focus for each lesson. Headings used may include, 'What we have learnt today?' and 'Vocabulary.' (U)

Vocabulary used may include: group, number of groups, number in each group, shape, circle, triangle, quadrilateral, square, rectangle, pentagon, hexagon, octagon, orientation, features, side, vertex (vertices), vertical, horizontal, portrait (orientation), landscape (orientation) and parallel. (U)

Student tasks

(i) Students are to arrange counters using the same pattern as Kandinsky (array of 3×4). Once a configuration of 3×4 has been established, students are to create their own amounts of rows or groups of circles. This may be created digitally as well as with texta dots, paint dots, pencil dots, whiteboard markers or stickers. ***(U) (F) (PS) (R)
(ii) Using coloured pastels, crayons or paint, students are to create their own version of Kandinsky's circles using a different shape other than circles. Students are encouraged to think about the possibilities, including pentagons, hexagons or octagons. (PS) (R)

Differentiation

After initial whole class discussion students are encouraged to explore and investigate the mathematical aspects of the artwork in a variety of ways, allowing differentiation for ability levels as well as areas of interest and need.

Australian Curriculum Mathematics Outcomes : Numeracy Links

The proficiency strands **understanding (U), fluency (F), problem solving (PS)** and **reasoning (R)** are an integral part of mathematics content across the three content strands.

Shape: *Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features (ACMMG022)
Describe and draw two-dimensional shapes, with and without digital technologies (ACMMG042)

Measurement: Measure and compare the lengths and capacities of pairs of objects using uniform informal units (ACMMGO19)

Australian Curriculum Creative and Practical Arts outcomes:

- VAS1.1 Makes artworks in a particular way about experiences of real and imaginary things.
- VAS1.2 Uses the forms to make artworks according to varying requirements.
- VAS1.3 Realises what artists do, who they are and what they make.
- VAS1.4 Begins to interpret the meaning of artworks acknowledging the roles of artist and audience .

Year 1 and 2 Learning Task 3

An investigation of shape and perspective with Jeffrey Smart's 2nd Study for 'King of the Castle', 2009.

Including ATSI perspectives

Aboriginal 8 Ways of Knowing References:
Deconstruct - Reconstruct
Non-Verbal
Symbols and Images

http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds

Students may engage more effectively with the learning tasks if they are developed in terms of a narrative, placed in social contexts and the key words repeated and integrated in the interactions between teacher and student and student and student. Actions and physical activities can enhance conceptual understandings.

Authentic Assessment strategies

Students self assess the results of their work and their learning. A rubric sample can be found on the facing page.
Students' understanding is determined used by the language used when describing the artwork, through questioning as well as their reconstruction of the work and photographs.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Assessment
Students' comprehension is assessed through questioning during the whole class discussion.
Students may photograph their arrays and add text that explains what they have created using mathematical language. Some students will need some guidance and may need a cloze activity to help them use the language. For example:

This is my array showing ______ by _______.

I have ______ horizontal ______ and ______ vertical _______.

I have used shapes called ________. I would describe my shapes as having. (explain sides and corners).

This pattern reminds me of…

Useful websites to support teachers
http://www.wikiart.org/en/wassily-kandinsky/color-study-squares-with-concentric-circles-1913

http://www.youclevermonkey.com/2013/06/arrays-in-real-life.html.

Visual Arts: Years One and Two: A Photographic Investigation of Shape and Perspective with Jeffrey Smart's Second Study for 'King of the Castle', 2009

Resources Large-scale image of 'King of the Castle', wooden blocks in a variety of shapes including cones, cylinders and spheres, recycled paper towel rolls, camera or digital device, whole class mathematics journal

Introduction
Students observe, analyse and discuss what they see in the artwork. Guiding questions may include:

*What does 2Dimensional mean? *(U)*
*How do we know this is a 2Dimensional artwork? ***(PS)® (R)*
*Could a 2D artwork be changed to 3D dimensional? How? ****(R)*
What does 'bird's eye view' mean? (review) *(U)
*What view does the painter have in this image? ****(R)*
*How could we create this scene in the classroom? ***(PS)*
*Do we have to use a certain shape of a block or could we use a different shape? ***(PS)*
*Would a rectangular prism be a shape I could use to recreate this scene? ***(PS)*

Discussion
Mathematical terms used during the discussion can be listed in view of students in the whole class mathematics journal. Language used may include cylinder, sphere, prism, surface, flat surface, face and a curved surface. Understanding scale by using comparative language such as the cylinder is twice as big as the boy.

Differentiation

This task is a differentiated task in itself as it is teaching both the mathematical concepts and the art appreciation from the Creative and Practical Arts syllabus. After initial whole class discussion students are encouraged to explore and investigate the mathematical aspects of the artwork in a variety of ways, allowing differentiation for ability levels as well as areas of interest and need.

Australian Curriculum Mathematics Outcomes: Numeracy Links

The proficiency strands **understanding, fluency, problem-solving** and **reasoning** are an integral part of mathematics content across the three content strands.

Measurement and Geometry
Shape ACMMG037 - Compare and order several shapes and objects based on length, area, volume and capacity using appropriate uniform units
Using units of measurement ACMMG061 - Measure order and compare using familiar metric units of length, mass and capacity

Australian Curriculum Visual Arts outcomes

Explore ideas and artworks from different cultures and times, including artwork by Aboriginal and Torres Strait Islander artists, to use as inspiration for their own representations (ACAVAM110)

Present artworks and describe how they have used visual conventions to represent their ideas (ACAVAM112)

Year Two- Three Learning Task

An investigation of Mondrian's compositions of red, blue and yellow.

Including ATSI perspectives

Aboriginal 8 Ways of Knowing References:
Deconstruct - Reconstruct
Non-Verbal
Symbols and Images

http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds

Students may engage more effectively with the learning tasks if they are developed in terms of a narrative, placed in social contexts and the key words repeated and integrated in the interactions between teacher and student and student and student. Actions and physical activities can enhance conceptual understandings.

Authentic Assessment strategies

Peer interviews may be carried out. A rubric for a recorded interview can be found on the lesson plan.

Students' understanding is determined by the language used when describing the artwork, through questioning as well as their recreation of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Student tasks

(i) Using wooden blocks or any reused materials, students recreate the scene in the painting. It is important to give students time to explore the possibilities of using different shapes. *How does the scene look using different shapes? (U) (PS)*

(ii) Students photograph their 'King of the Castle' scene using a camera or digital device. Experimenting with at least three different angles is needed. Refer back to the class discussion. *What view does the painter have? (PS)*

(iii) Student's images can be printed or displayed digitally. Discuss the similarities and differences of the images. *Have we captured the same perspective as the painter?* (PS) (R)

(iv) It may be necessary to allow students more time to photograph their scene in order to grasp the concept of perspective.

Assessment

The work samples (photographs) the students produce will determine their understanding of the concept.

Rubric sample of self-assessment

I have…	Star rating
I have recreated the painting using blocks	
I have taken a photo that shows a bird's eye view	
I have taken a photo that shows a worm's eye view	
I have taken a photo that shows a side view of the scene	
I have taken a photo that shows a close-up view of the scene	
I have taken a photo that shows an eye-level view	

Useful website to support teachers

http://www.wikiart.org/en/jeffrey-smart/2nd-study-for-king-of-the-castle-2009.

http://portals.studentnet.edu.au/literacy/Minisites/SCEGGSDarlinghurstrevised/vliteracy/angles.htm.

Visual Arts: Years Three and Four: Mondrian's Compositions of Red, Blue and Yellow

Resources Large-scale image of Mondrian's compositions of red, blue and yellow. 1 cm cubes, translucent 1 cm grid sheet, paper, drawing utensils, a 30 cm ruler, an A4 colour copy of the artwork for each student.

Introduction

Students are to analyse Mondrian's compositions of red, blue and yellow. Guiding questions may include the following:

*Can you describe the lines you can see? *(U)*
*Can you describe the shapes you can see? *(U)*
*How could you describe a square to a toddler? Is 'four sides' enough information? **(F)*
*How could you describe a rectangle or a rhombus to a toddler? Is 'four sides' enough information? **(F)*
*What does area mean? *(U)*
*What might be the shape with the smallest area? Largest area? **(F)*

Discussion

List mathematical terms, encourage and record metalanguage in whole class mathematical vocabulary journal. **(U) (F)

This can be referred to at the start and end of each lesson. Mathematical terms may include, for example:

Two-dimensional, shape, rectangle, left, right, horizontal, rhombus, square, trapezium, kite, regular shapes and irregular shapes.

Student tasks

(i) Students may work in groups or individually. Using the A4 colour version of Mondrian's artwork, students cut along black lines. Students compare areas just by looking. Predict the area of each shape and write their predictions on each shape. Measure, order and compare shapes. Students line up shapes from smallest area to largest area and measure the area of shapes using the 1 cm cubes or translucent 1 cm grid sheet. *Were the predictions correct? ** (F) ***(PS)*

(ii) Students reconstruct the artwork using the smaller area shapes at the top of their reconstruction, working down to the larger area shapes. ***(PS)
*Does the result need to form a square or rectangle? Could the reconstruction form a different shape, an irregular shape? Do the colours represent different areas? ****(R)*

(iii) Allow students time to experiment with their reconstruction and the possible irregular shapes it may form. ***(PS) ****(R)

Assessment
Peer interviews conducted in small groups or pairs.
Interview sample:

Questions asked interviewer (name of student)	Answer given by interviewee (name of student)
Explain Mondrian's work using some mathematical language	*Answer may be written in this space by interviewer or recorded using a digital device*
Explain what area is and how you created your artwork using what you know about area	*Answer may be written in this space by interviewer or recorded using a digital device*

Students' artworks will demonstrate their understanding of the concept.

Useful website to support teachers
http://www.wikiart.org/en/piet-mondrian/composition-c-no-iii-with-red-yellow-and-blue-1935.

https://www.youtube.com/watch?v=1dqAOKdJmRI.

Differentiation

This task is teaching both the mathematical concepts and the art appreciation from the Creative and Practical Arts syllabus.
Students are encouraged to work in a way that suits them, either individually, in pairs or small groups.

Differentiation occurs through open ended questioning and allows students to develop knowledge at an appropriate level to each individual.

Australian Curriculum Mathematics Outcomes: Numeracy Links

The proficiency strands understanding, fluency, problem-solving and reasoning are an integral part of mathematics ~~content~~ across the three content strands.

Geometric Reasoning ***Angles***- ACMMG064 : Identify Angles as measures of turn and compare angle sizes in everyday situations. ACMMG089 : Compare angles and classify them as equal to, greater than, or less than, a right angle. ACMMG091: Create symmetrical patterns, pictures and shapes with and without digital technologies. ***Shape* -** ACMMG087, ACMMG088 : Compare and describe two dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies. Regular and Irregular shapes .

Australian Curriculum Visual Arts outcomes

Explore ideas and artworks from different cultures and times, including artwork by Aboriginal and Torres Strait Islander artists, to use as inspiration for their own representations (ACAVAM110)

Use materials, techniques and processes to explore visual conventions when making artworks (ACAVAM111)

Year Three and Four Learning Task

An investigation of Carl Kleiner's

geometric photography: the "BÆRTLING WANNABE" series

Including ATSI perspectives

The geometric shapes in some of Reko Rennie's works could be used to show another example of right angles.
Aboriginal 8 Ways of Knowing References:
Deconstruct - Reconstruct
Non-Verbal
Symbols and Images
http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds

Students may engage more effectively with the learning tasks if they are developed in terms of a narrative, placed in social contexts and the key words repeated and integrated in the interactions between teacher and student and student and student. Actions and physical activities can enhance conceptual understandings.

Authentic Assessment strategies

Students self assess the results of their work and their learning. A rubric sample can be found on facing page.

Students' understanding is determined by the language used when describing the artwork, through questioning as well as their reconstruction of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Visual Arts: Years Three and Four: Carl Kleiners Geometric Photography, the 'BÆRTLING WANNABE' Series

Resources Large-scale image of Carl Kleiner's geometric photography, the 'BÆRTLING WANNABE' series, cameras or digital devices for photographing angles, poster paper, markers, coloured paper or card, bread or food that is flat and able to be cut with a plastic picnic knife.

Introduction
Students are to analyse the image. Guiding questions may include:

*Can you describe the lines you can see? *(U)*
*Can you describe the shapes you can see? *(U)*
*Describe the angles inside the shapes. *(U)*

Discussion
List mathematical terms, encourage and record metalanguage in whole class mathematical vocabulary journal.

This can be referred to at the start and end of each lesson. Mathematical terms may include, for example:

Two-dimensional, shape, regular shapes, irregular shapes triangle, angle, right angle, obtuse, acute, arms and vertex.

Student tasks

(i) Angle hunt. Search around the classroom and in the school grounds for right angles, obtuse angles and acute angles. **(U) (F)
(ii) Photograph their findings. After discussing their findings, view Kleiner's artwork again. Compare student photos to Kleiner's work. Discuss similarities and differences. List similarities and difference as a whole class using a whiteboard or poster paper. ***(PS)
(iii) Students create their own version of Kleiner's geometric photography using only acute and obtuse angles (no right angles). *Is this possible? How?* Using bread or any flat food that can be cut, students cut their shapes and arrange them in a composition on brightly coloured paper. ***(PS)
(iv) Kleiner's cheese image can be viewed to show the students an example of right angles in the artwork. Their creation will look different as their angles will be different. *Are there foods that naturally have acute angles inside them?* View Dennis Wojtkiewicz citrus fruit painting and compare the angles inside the fruit (segments of an orange) to Kleiner's cheese image.
(v) Students photograph their composition similar to Kleiner's food photographs and explain their artwork to classmates using mathematical language.

Differentiation

This task is a differentiated task in itself as it is teaching both the mathematical concepts and the art appreciation from the Creative and Practical Arts syllabus.

Choice of construction processes is available. Some students may use the newspaper rolling technique while others may need more guidance. Nets that are flat may be used for some whereas reused cereal boxes may be needed for others.

Australian Curriculum Mathematics Outcomes: Numeracy Links

The proficiency strands **understanding, fluency, problem-solving** and **reasoning** are an integral part of mathematics content across the three content strands.

Geometric Reasoning

ACMMG064, ACMMG088 , ACMMG089 : Identify and compare angles and classify, apply to everyday objects. Compare, describe and create 2D objects that are the result of combining and splitting common shapes, with or without digital technologies

Shape

ACMMG063 : Make 3-D models and describe their key features

ACMMG115: Apply the enlargement transformation to familiar two dimensional shapes and explore the properties of the resulting image compared with the original

Australian Curriculum Visual Arts outcomes

Use materials, techniques and processes to explore visual conventions when making artworks (ACAVAM111)

Year Three and Four Learning Task 3

A comparison and analysis of 2D and 3D looking at Pippa Andrews' "Standard Square" works.

Including ATSI perspectives

Aboriginal 8 Ways of Knowing References:
Deconstruct - Reconstruct
Non-Verbal
Symbols and Images

http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds

Students may engage more effectively with the learning tasks if they are developed in terms of a narrative, placed in social contexts and the key words repeated and integrated in the interactions between teacher and student and student and student. Actions and physical activities can enhance conceptual understandings.

Authentic Assessment strategies

Students self assess the results of their work and their learning. A rubric sample can be found on facing page.

Students' understanding is determined used by the language used when describing the artwork, through questioning as well as their recreation of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Assessment
Student self-assessment Rubric

My geometric artwork…	Score out of 10	Explanation in words
Contains……acute angles		*Further explanation is encouraged to clarify and document the depth of student understanding*
Contains……obtuse angles		
Has no right angles		
Has a variety of different sized triangles		

Useful website to support teachers
http://www.carlkleiner.com.
http://www.yellowtrace.com.au/carl-kleiner-photography/.
https://www.pinterest.com/jennyehiggins/art-dennis-wojtkiewicz/.

Visual Arts: Years Three and Four: A Comparison and Analysis of 2D and 3D Looking at Pippa Andrews' 'Standard Square' Works

Resources Large-scale image of Mondrian's compositions of red, blue and yellow, the large-scale image of Pippa Andrews' 'Standard Square' works, camera or digital device, whiteboard, poster-sized paper, old newspapers or magazines, pencils, paper, reused cereal boxes or small square-based or rectangular-based boxes.

Introduction
Students are to analyse Mondrian's compositions of red, blue and yellow. Guiding questions may include:

*What shapes can be seen in Mondrian's work? *(U)*
*Are the shapes two-Dimensional or three-Dimensional? How do you know? *(U) **(F)*
*Explain what 2D means/what 3D means. *(U).*
What is the origin words of 'dimensional'? Does that tell us anything about the shapes?(U)*

*What if Mondrian's work was a 'bird's eye view' of something 3D? What might the objects be? ***(PS)*

Discussion

Encourage and record metalanguage in whole class mathematical vocabulary journal.

This can be referred to at the start and end of each lesson. *(U)

Student tasks

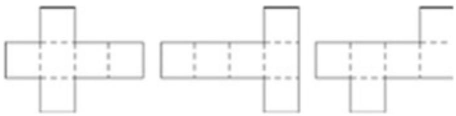
(i) Investigate the textile work of Pippa Andrews. Compare Mondrian's composition to Andrews' 'Standard Square' works. *How are the works similar? Different*? Discuss the three-dimensionality of Andrews' work compared to Mondrian's. ***(PS)

(ii) Using sketches students draw plans and designs of their own 3D construction. ***(PS)

(iii) Using the rolling newspaper method, students collaboratively recreate Mondrian's right angles into a three-dimensional construction. Allow students time to experiment with their construction. ***(PS)

(iv) Students are encouraged to reflect and refine their work during the construction process. ***(PS) ****(R)

(v) Students may create and enlarge their own 3D shapes appropriate for the task using nets. Nets may be provided, or students may create their own. This allows students the opportunity to design, manipulate and discover more about the 3D shapes they are creating. Reused cereal boxes may also be used. ***(PS)



Assessment

Students' comprehension is assessed through questioning during the whole class discussion.

Student work samples of their reconstruction.

Self-Assessment Sample:

Our construction…	Score out of 10	Explanation in words
Contains only right angles		
Has a variety of square and rectangle prisms in different sizes		
Is strong and sturdy		

Useful website to support teachers

http://www.wikiart.org/en/piet-mondrian/composition-c-no-iii-with-red-yellow-and-blue-1935.

http://www.pippaandrews.com/page2.htm.

https://allencentre.wikispaces.com/Rolled+Newspaper+Structures.

http://www.greatmathsteachingideas.com/wp-content/uploads/2012/03/Making-3D-Shapes.pdf.

https://www.youtube.com/watch?v=TeQD4IRzk2c.

https://www.youtube.com/watch?v=7VEXuJZlhQw.

Differentiation

This task is a differentiated task in itself as it is teaching both the mathematical concepts and the art appreciation from the Creative and Practical Arts syllabus. After initial whole class discussion students are encouraged to explore and investigate the mathematical aspects of the artwork in a variety of ways, allowing differentiation for ability levels as well as areas of interest and need.

Australian Curriculum Mathematics Outcomes: Numeracy Links

The proficiency strands **understanding, fluency, problem-solving** and **reasoning** are an integral part of mathematics content across the three content strands.

Location and Transformation Outcome: ACMMG114 & ACMMG115: Apply the enlargement transformation to similar 2 dimensional shapes and explore the properties of the resulting image compared with the original

Geometric Reasoning Outcome: ACMMG089, ACMMG112 : estimate, measure and compare angles using degrees. Construct angles using a protractor.

Australian Curriculum Creative and Practical Arts outcomes:

Develop and apply techniques and processes when making their artworks (ACAVAM115)

Explore ideas and practices used by artists, including practices of Aboriginal and Torres Strait Islander artists, to represent different views, beliefs and opinions (ACAVAM114)

Year 4-5 Task

A mathematical investigation of Frank Stella's "Khurasan Gate III" (1968)

Including ATSI perspectives

Identify symmetry in local indigenous art as well as in the land. http://artsearch.nga.gov.au/

Aboriginal 8 Ways of Knowing References:
Deconstruct - Reconstruct
Non-Verbal
Symbols and Images
Land Links

http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds: The concepts of colour and shape are readily available in the traditional textile constructions and beadwork of these groups, especially the traditional cape worm by women. Investigations by the class of Dinka art images may support the students' learning.

Authentic Assessment strategies

Students self assess the results of their work and their learning. A rubric sample can be found on facing page.

Students' understanding is determined used by the language used when describing the artwork, through questioning as well as their recreation of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Visual Arts: Years Five and Six—Numeracy and Visual Art: Lessons One Stella's Colour Maze

Resources Large-scale image of Frank Stella's 'Colour Maze' (1966). Digital devices with the 'Hopscotch' Application. Variety of materials from which to construct 3D solids, grid paper, other paper for drawing, writing and illustrating or electronic devices for this task, outlines of the artwork, no colour.

Introduction
Students observe, analyse and discuss what they see in the artwork. Guiding questions may include:

*Can you describe the lines you can see? *(U)*
*Can you describe the 2D shapes you can see? *(U) **(F)*
*What angles can be seen? *(U)*
*How many triangles? Which types? How many quadrilaterals? Other 2D shapes? ***(PS)*
How is the sense of movement achieved?
*Why/ how does it achieve a sense of three-dimensionality? *(U) ***(PS)*
*Can you map the colour patterns? **(PS)*
*What are the relationships of the colour patterns? **(PS)*
*What may happen if the dark and lighter colours had their positions changed? ***(PS)*

Discussion
List mathematical terms, encourage and record metalanguage

Observe the online artwork closely
Zoom in and focus clearly on the lines and the angles

Tasks Student selected

(i) Create a 3D representation of the 2D work—Ensure that the lines are straight and the angles sharp. *(PS)
(ii) Discuss and describe the movement of the work in terms of visual–spatial metalanguage—draw diagrams and illustrations to form part of the description. ***(PS)
(iii) Discuss the relationships of the colour patterns in terms of visual–spatial metalanguage—draw diagrams and illustrations to form part of the description. ***(PS)
(iv) Map the colour patterns in terms of light and dark tones. Define your understandings of light and dark using appropriate mathematical metalanguage. Use grid paper for the mapping or use an electronic device. ***(PS)

Differentiation

This task is a differentiated task in itself as it is teaching both the mathematical concepts and the art appreciation from the Creative and Practical Arts syllabus. The fractions investigated can range from basic halves to more advanced equivalent fractions, decimals and percentages, depending on student ability.

Australian Curriculum Mathematics Outcomes

The proficiency strands **understanding, fluency, problem-solving** and **reasoning** are an integral part of mathematics content across the three content strands.

Fractions and Decimals : ACMN078**,**

ACMNA102: Compare and order common unit fractions and locate and represent them on a number line.

ACMNA103: Investigate strategies to solve problems involving addition and subtraction of fractions with the same denominator

ACMNA114: Describe translations, reflections and rotations of two dimensional shapes. Identify line and rotational symmetries.

Australian Curriculum Creative and Practical Arts outcomes

Explore ideas and practices used by artists, including practices of Aboriginal and Torres Strait Islander artists, to represent different views, beliefs and opinions (ACAVAM114)

Develop and apply techniques and processes when making their artworks (ACAVAM115)

Year Four- Five Task

A mathematical investigation of Dennis Wojtkiewicz's citrus fruit paintings (2013)

Including ATSI perspectives

Identify symmetry in local indigenous art as well as in the land. http://artsearch.nga.gov.au/

Aboriginal 8 Ways of Knowing References:

Deconstruct - Reconstruct

Non-Verbal

Symbols and Images

Land Links: Students may search for fractions within nature, e.g. spider webs, leaf patterns, flower petals.

http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds: all students can investigate the notions of symmetry, fractions and partitioning using traditional beadwork images and other cultural artefacts. These will be embedded in story and poetry that is important to these groups and can be shared with others.

Authentic Assessment strategies

Students' photography and matching text will demonstrate their understanding of the concepts.

Students' understanding is determined used by the language used when describing the artwork, through questioning as well as their recreation of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction.

Linking the focus artwork to previous artworks discussed and viewed may help to create context and relevance.

(v) Chart and count all the various types of triangles, squares, quadrilaterals and other 2D shapes that you can find in the artwork. Use different coloured pencil outlines to identify shapes within shapes and overlapping shapes-discuss the findings in terms of relationships using mathematical meta language. ***(PS)

Useful website and videos to support teachers
http://www.wikiart.org/en/frank-stella/color-maze-1966.
https://www.gethopscotch.com.
https://www.wikiart.org/en/frank-stella/khurasan-gate-iii-1968.

Visual Arts: Years Five and Six: Dennis Wojtkiewicz's Citrus Fruit Paintings (2013)

Resources Large-scale image of Dennis Wojtkiewicz's citrus fruit paintings (2013). Large-scale image of Pippa Andrews' Standard Quilt (2012). Cameras or any digital device that can be used as a camera, citrus fruit, plastic picnic knives paint, art paper and old newspaper, Microsoft paint and Photoshop.

Introduction
Students are to analyse Dennis Wojtkiewicz's citrus fruit paintings (2013). Guiding questions may include the following:

*What can you see? *(U)*
*Can you describe the sections (fragments, segments or fractions) of the fruit? *(U), **(F)*
*What mathematical words can be used to describe the work? *(U)*

Can this artwork be compared to a protractor like Stella's work? 8 (PS)
*How would the artwork look if the segments were 10°? 20°? 30 °? ***(PS)*
*Could this be compared to any other foods? (other foods with segments and fractions of a whole) ****(R)*
If you were to give a name to each segment, what might they be called in terms of fractions or percentages?
If there is an odd number of segments, how might I divide them into halves? quarters? eighths?
What does the citrus painting have in common with 'Standard Quilt'?

Discussion

List mathematical terms, encourage and record metalanguage in whole class mathematical vocabulary journal.

This can be referred to at the start and end of each lesson.

Student tasks

(i) Cut up citrus fruit and observe the amount of segments within each piece of fruit. Discuss what their fruits are divided into—eighths? tenths? *(U), **(F)
(ii) Students photograph their own piece of fruit. *How has Wojtkiewicz created the light behind his fruit? Can students recreate the same angle and intensity of light*? Students upload their images to Photoshop and use dodge and burn techniques to emphasise the segments, making them more prominent. Add text that explains how the fruit has been divided. For example, 'My fruit is naturally divided into eighths. Each eighth represents 12.5%. If someone ate 25% of my slice of fruit, it would mean two segments.' ***(PS).

(iii) Relate understanding of fraction, decimals and percentages to Pippa Andrews' Standard Quilt (2012). *What is the percentage of dark colours? light colours? Why has the artist created this particular ratio of tones? *** (PS)* http://www.textileartist.org/pippa-andrews-interview-part-one-textile-art-in-its-loosest-sense/.

(iv) Using paint or prints of their fruit slices, or illustrations, students create a square pattern on art paper with a predetermined colour proportions. Some students may be able to develop their own colour proportions and others may need more guidance. This can be as basic or as advanced as needed. Example of basic: using a 10 by 10 grid, 50% of my prints will be red, 25% will be grey and 25% will be green. Examples of extension: change the size of the grid, students determine their own proportions. This activity could also be done in Photoshop or Microsoft Paint. ***(PS)

Assessment procedures

Students' comprehension is assessed through questioning during whole class discussion.

Students' photography and matching text will demonstrate their understanding of the concepts.

Students may keep an individual mathematics journal. The journal may be written in at the end of each lesson, documenting what had been learnt and the vocabulary used.

Useful website and videos to support teachers

http://www.textileartist.org/pippa-andrews-interview-part-one-textile-art-in-its-loosest-sense/ http://twistedsifter.com/2013/01/translucent-fruit-paintings-by-dennis-wojtkiewicz/.

Year Five and Six Learning Task 1

A mathematical investigation of Frank Stella's "Untitled" (1966).

Differentiation

This task is a differentiated task in itself as it is teaching both the mathematical concepts and the art appreciation from the Creative and Practical Arts syllabus. After initial whole class discussion students are encouraged to explore and investigate the mathematical aspects of the artwork in a variety of ways, allowing differentiation for ability levels as well as areas of interest and need.

Australian Curriculum Mathematics Outcomes : Numeracy Links

The proficiency strands **understanding, fluency, problem-solving** and **reasoning** are an integral part of mathematics content across the three content strands.

Location and Transformation ACMMG114 & ACMMG115: Describe translations, reflections and rotations of two-dimensional shapes. Apply enlargement transformation to familiar two dimensional shapes and explore the properties of the resulting image compared to the original.

Geometric Reasoning ACMMG112, ACMMG141 : Estimate, measure and compare angles using degrees. Construct angles using a protractor.

Australian Curriculum Creative and Practical Arts outcomes

Explore ideas and practices used by artists, including practices of Aboriginal and Torres Strait Islander artists, to represent different views, beliefs and opinions (ACAVAM114)

Develop and apply techniques and processes when making their artworks (ACAVAM115)

Explain how visual arts conventions communicate meaning by comparing artworks from different social, cultural and historical contexts, including Aboriginal and Torres Strait Islander artworks (ACAVAR117)

Including ATSI perspectives

Frank Stella's "Untitled" (1966) can be compared to Timmy Payungka Tjapangati's "Untitled" (1998) by all the students http://www.artgallery.nsw.gov.au/collection/works/215.2000/

Aboriginal 8 Ways reference:

Deconstruct
Reconstruct
Non - verbal
Symbols and Images
http://8ways.wikispaces.com/8way+maths

Strategies to include learners with oral backgrounds: Students may be able to identify similar design on textiles and fabrics that are familiar to them. These can also be compared by the whole class to the other artworks to support deep understanding and conceptual knowledge. Students may engage more effectively with the learning tasks if they are developed in terms of a narrative, placed in social contexts and the key words repeated and integrated in the interactions between teacher and student and student and student. Actions and physical activities can enhance conceptual understandings.

Authentic Assessment strategies

Students self assess the results of their work and their learning. A rubric sample can be found on facing page.

Students' understanding is determined used by the language used when describing the artwork, through questioning as well as their recreation of the work.

Variations for students from diverse social contexts

Students may not be familiar with art galleries, famous painters or seminal works. They may need extended background and introduction. Others may not think of art as non -representational. Explicit links may need to be made to pattern, design and placement of objects in familiar articles, places or illustrations

Visual Arts: Years Five and Six: Frank Stella's 'Untitled' (1966)

Resources Large-scale image of Frank Stella's 'Untitled' (1966). Digital devices with the 'Hopscotch' Application. Variety of materials from which to construct 3D solids, grid paper, other paper for drawing, writing and illustrating.

Introduction

Students observe, analyse and discuss what they see in the artwork. Guiding questions may include:

*Can you describe the lines you can see? *(U)*
*Can you describe the 2Dimensional shapes you can see? *(U)*
*What angles can be seen? *(U)*
*How many triangles? Which types? How many quadrilaterals? Other 2D shapes? ***(PS)*
How is the sense of movement achieved? (U)
*Why/ how does it achieve a sense of three-dimensionality? ***(PS)*
*Can you map the colour patterns? ***(PS)*
*What are the relationships of the colour patterns? ***(PS)*
*What may happen if the dark and lighter colours had their positions changed? ***(PS), ****(R)*

Discussion

List mathematical terms, encourage and record metalanguage.
Observe the online artwork closely.
Zoom in and focus clearly on the lines and the angles.

Student tasks

(i) Create a 3D representation of the 2D work—Ensure that the lines are straight and the angles sharp. ***(PS)
(ii) Discuss and describe the movement of the work in terms of visual–spatial metalanguage—draw diagrams and illustrations to form part of the description. *(U), **(F)
(iii) Discuss the relationships of the colour patterns in terms of visual–spatial metalanguage—draw diagrams and illustrations to form part of the description. ***(PS)
(iv) Map the colour patterns in terms of light and dark tones. Define your understandings of light and dark using appropriate mathematical metalanguage. Use grid paper for the mapping or use an electronic device. ***(PS)
(v) Chart and count all the various types of triangles, squares, quadrilaterals and other 2D shapes that you can find in the artwork. Use different coloured

pencil outlines to identify shapes within shapes and overlapping shapes-discuss the findings in terms of relationships using mathematical metalanguage. Create the 2D shapes that can be seen in the artwork using the 'Hopscotch' app. ***(PS)

(vi) Compare the tones and patterns of the darks and lights to another artwork. See Pippa Andrew's 'Standard Quilt Tumbling Blocks' at http://www.pippaandrews.com/page2.htm.

Student Self-Assessment

What I can do, what I know and what I understand	Further explanation in words	Score yourself out of 10
I can use mathematical language when I describe the artwork		
I have a solid understanding of the patterns in the artwork and can describe them or recreate them		
I created my own 2D or 3D version of the artwork or elements within the artwork		

Useful website and videos to support teachers

http://20thcenturyartmovements.weebly.com/minimalism.html.
http://www.pippaandrews.com/page2.htm.
https://www.gethopscotch.com.

References

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