Supporting EAL/D learners with numeracy

Rationale

The Multicultural Education Policy commits schools to providing opportunities that enable all students to achieve equitable education and social outcomes and participate successfully in our culturally diverse society. Whiteford (2010) argues that a student's 'first mathematics' shapes their mathematics as much as a student's home language shapes their understanding of language. In NSW public schools, approximately 25% of students are EAL/D learners, who come from a range of language, cultural and educational backgrounds. Students learning English are simultaneously learning the English language, learning in English, and learning about English (Halliday, 1993). EAL/D learners include Aboriginal and Torres Strait Islander students who may use Aboriginal English or other Aboriginal ways of using English, who may also speak a creole or a traditional language, and Australian and overseas born students whose home language is a language other than English. EAL/D learners bring to the classroom conceptions of mathematics and numeracy based on their home language and prior educational and life experiences. The information in this guide supports teachers to plan differentiated explicit teaching to align with system priorities in numeracy and meet the commitments in the Multicultural Education Policy.

Timeframe for use

This document should be referred to when planning and programming units of learning and for professional conversations on supporting the numeracy learning needs of EAL/D students.

Intended audience

School leaders, primary teachers, secondary teachers, EAL/D and LaST specialist teachers.

Instructions for use

This document should be read and discussed when planning units of learning which contain numeracy skills and knowledge, and in assessing EAL/D learners on the National Numeracy Learning Progression.

What is numeracy?

NESA defines numeracy as ‘Students become numerate as they develop the capacity to recognise and understand the role of mathematics in the world around them and the confidence, willingness and ability to apply mathematics to their lives in constructive and meaningful ways’ (NESA Literacy and numeracy).

The equity implications of being numerate is argued by Siemons and others (2020): ‘the ability to meet the numeracy demands of daily life can determine who is able to participate and contribute most effectively in home life, at work and in community life’, and this statement is supported by CESE’s 2016 report, ‘How schools can improve literacy and numeracy performance and why it (still) matters’ which charts a relationship between a range of life outcomes and numeracy.

EAL/D learners and numeracy

EAL/D learners bring varying numeracy knowledge to the classroom. Their language, education history, background knowledge and culture intersect with their understandings of numeracy. Some EAL/D students may be extremely strong in areas of mathematics but are challenged in demonstrating what they know when faced with questions containing literacy, language and cultural knowledge that differs from theirs. Other students may have extremely limited numeracy skills and knowledge, including in their home language. All EAL/D learners will require some level of support with the language, literacy and cultural elements of numeracy. The idea that ‘mathematics is a universal language’ has been shown to have limited credence (Perso, 2016 and Whiteford, 2010). While the laws of mathematics are consistent across the globe, what is prioritised in numeracy – for example, what is taught and how it is taught – can vary greatly across educational systems. Whiteford (2010) argues that knowing EAL/D learners’ ‘first mathematics’ is of equal importance as knowing their proficiency in home language and their English language proficiency.

First mathematics

How might students’ ‘first mathematics’ present in the classroom? There may be differences in notation, mathematical procedures, degree of abstraction and use of manipulatives, how mathematics is understood culturally, and the language of mathematics and numeracy.

Notation can vary. For example, Australian-educated students may use a comma or a space to separate groups of three digits while some EAL/D learners may use a period, apostrophe or semi-colon and use the interpunct symbol • or an asterisk * for multiplication. Having discussions on how notation is used in students’ ‘first mathematics’ fosters an inclusive classroom, allowing all students to see how different cultures and languages understand and do mathematics.

According to Whiteford (2010), ‘it is in the area of procedural knowledge where the greatest variation in mathematics can occur between different cultures,’ so encouraging students to share how they did maths in their home language and culture is an effective inclusive teaching strategy, as it values students’ conceptual understanding which have different notations and procedures.

These concepts may also be applicable to Aboriginal and Torres Strait Islander students who may be 'focused on functionality [in mathematics] as it pertains to culture and life' (Perso, 2016). The following ideas on fostering inclusive mathematics and numeracy learning for Aboriginal and Torres Strait Islander students are drawn from Aboriginal and Torres Strait Islander Mathematics Alliance and 8 ways of learning – 8 ways maths: using visuals and creating symbols and promoting these as Aboriginal forms of communication, using talk to explore problems and connect content to real life, highlighting the mathematics and numeracy in Country and culture.

EAL/D learners, including students who speak a traditional language or Aboriginal dialects of English, may not have experience in using common manipulatives to represent their numeracy knowledge. Communities may have particular objects or ways representing number and operations which can be incorporated into classroom practices.

Language in numeracy

EAL/D learners may need support to develop and consolidate how language is used in numeracy contexts – the mathematical register (Halliday and Hasan, 1985) – as it may differ from their home language of mathematics and require opportunities to explore vocabulary in word problems.

EAL/D learners may need explicit teaching in understanding 'false friends', which are terms that have a distinctive meaning in a numeracy context, different from their use in everyday English. There are resources targeting vocabulary in numeracy to assist EAL/D learners achieve in the HSC minimum standard, which may be applicable to students in other stages of schooling. A comprehensive list of the numeracy vocabulary appearing in past NAPLAN papers can be found in Paul Swan's 'My word book: mathematics' (2018). Beck, McKeown and Kucan's (2013) distinction between the tiers of vocabulary recommends building Tier 2 vocabulary; EAL/D numeracy learners will benefit from this as well as consolidation of Tier 1 words (everyday spoken words) at point of need. For example, the use of prepositions in written or spoken language such as 'of', 'off', 'from' and 'by' may need to be explicitly taught in context, as well as the numeracy phrases in which these prepositions are typically found, such as: percentage off, percentage of, take away from, times by. Advice on selecting and teaching Tier 2 words is available.

Another well-researched area in the language of mathematics is the 'reversal error': this is when the way a number sentence is spoken differs from the way it is written. For example, we might ask our class to 'Take 7 away from 15' but as a number sentence it would be written as 15 – 7. An EAL/D learner may be confused as to which number to subtract if only given oral instructions. HSC minimum standard resources have been created to learn ways to explicitly teach the role of syntax in mathematics and numeracy, which may be applicable to students in other stages of schooling.

Word problems have a significant language component. Diagnostic tools such as Newman's Error Analysis can help assess where a student's numeracy understanding is breaking down in word problems, and strategies such as the Three reads can be used to support EAL/D learners with reading numeracy questions.

Visuals in numeracy

Visuals are frequently used in numeracy. They can be an element in a numeracy question, a resource to convey numeracy information, or a tool allowing students to demonstrate their numeracy knowledge. Graphics are commonplace in standardised numeracy tests. Diezmann and colleagues (2008) make an important distinction between contextual and information graphics. Information graphics contain essential information for solving the question while contextual graphics further illustrate the context or story of the question and are incidental to the information needed for answering the question. Whether or not graphics contain essential information should be taught to EAL/D learners as they may not be familiar with these two roles of graphics in numeracy questions.

Visuals which are common resources for teaching such as maps, graphs, flow charts and diagrams, may need to be explicitly taught to EAL/D learners, dependent on their prior numeracy knowledge and the context in which these visuals are being used. The language of visuals, such as axis, axes, scale, grid lines, compass rose, multidirectional arrows and so forth, should also be taught in context of the use of the visual and how to interpret the information they convey.

Visuals can also be a tool for students to solve numeracy problems and demonstrate their numeracy knowledge. Jo Boaler, and her website Youcubed, places visuals at the centre of mathematics, and promotes a number of evidence-based ways to assist students to see mathematics such as visual proof and numberless graphs. Other visual methods to understand numeracy problems include the Bar Model Method, and graphic organisers such as Think boards (PDF 102 KB) and the Frayer Model.

Talking numeracy

There is well-developed literature on the importance of talking in numeracy, which dovetails with the research in EAL/D pedagogy on ‘talking to learn’ (Askew 2011, Gibbons 2009, 2015, Jones 1996, Kazemi and Hintz 2014). Well-planned and structured talk builds both EAL/D learners’ English language proficiency and numeracy. Teacher talk is important as a model of proficient English language use, and teacher talking strategies such as extended IRF (initiation, response, feedback), appropriating and recasting scaffold the English language and numeracy development of students.

Creating opportunities for students to talk numeracy in purposeful and planned ways is an effective classroom strategy to build English language knowledge and numeracy. Key student talking strategies include: Notice and wonder (staff only), Talk moves, Number talks and communicative activities (see Resources for a selected list of communicative activities).

Key takeaways

English language proficiency and literacy are integral to success in numeracy. There are many words that have particular meanings in numeracy, and language is used in a distinctive way in numeracy contexts (the ‘mathematical register’). EAL/D learners will need ongoing support with understanding the language of mathematics and numeracy. Visual tools can support numeracy

learning by allowing students to represent numeracy knowledge in ways that are independent from their English language proficiency. Well-planned and structured talk is a highly effective method to both develop students' English language knowledge and numeracy knowledge.

Resources

A selected list of communicative activities:

Word barrier games: students are given two documents with different information which requires them to ask questions or explain something to complete both documents. The language should be academic and KLA specific.

Image barrier games: students need to discuss their mathematical symbol without saying its proper name.

Opinion gap: A talking activity in which a pair of students need to arrive at a consensus about a statement. For example: 4(9+18) is greater than 9(4+18). The students will need to justify their opinion, therefore engage in mathematical reasoning.

Communicative crosswords: pairs of students receive one half of a completed crossword without the word clues. The students need to come up with a definition of their word, which from their partner guesses the missing word in their copy of the crossword, and add it to their crossword.

Find the difference: Two images with several differences. Tell the students how many differences there are. Students need to describe their image and their partner needs to compare their image to the verbal description For example, a Find the difference with different clocks – analogue, digital, 24 hour – telling a range of times.

Picture sequencing: Students sequence a range of images in pairs. One student reads a description, while the other student places the images representing the description in the correct order. A range of clock faces could be sequenced from the clock showing the time closest to midnight to the time closest to midday, for example. Then the student who sequenced the images tells the story of the images while the reader checks against the description.

Picture-sentence matching: Two sets of cards, one with the pictures and the other with the sentences. Student A describes their picture and Student B finds the sentence which matches. Examples include: different clock faces to be matched with sentences with the time; a variety of graphs and sentences describing the graphs; an image of a number of shapes and objects to be matched with sentences describing the shapes and objects. This is effective communicative task for students who are the early stage of English language learning.

Word-picture matching: Useful for students who are the early stage of English language learning. Working in pairs, students could discuss the picture in home language before attempting to match with the word in English.

(Adapted from Gibbons, 2009 and Hertzberg, 2012).

Professional learning

The NESA accredited professional learning, Numeracy for EAL/D learners, expands the information and strategies detailed in this teacher advice guide

Glossary

Appropriating and recasting – a teacher talking strategy in which the teacher models Standard Australian English and KLA-specific language by 'borrowing and reformulating' the EAL/D learner's language (Gibbons 2009). For example, the EAL/D learner may use the inappropriate tense and not know the noun for an object: 'I bringed the thing with me.' Teacher: What did you bring? Can you show me? Ah, you **brought** a square object to school. Did you bring any other objects?'

Extended IRF – also known as the 'fourth move', extended IRF is a pattern of teacher questioning-student response which gives EAL/D learners the opportunity to be 'worthy participants' in an academic conversation as well as probing both their content and language knowledge of the topic (Gibbons 2009). IRF (initiation, response, feedback) is the conventional classroom questioning in which the teacher initiates an exchange by asking a question, a student responds, and then the teacher offers feedback, usually with an evaluative comment such as 'good', 'yes' or 'that's right'. To extend the verbal exchange, the teacher refrains from evaluative feedback and ask the student to explain, expand or justify their response. Depending on the question and situation, a teacher could say 'tell me more why about you think that 'or 'remember what we learned about yesterday, was there some language which you could use?' to stretch both the EAL/D learner's understanding of content and language.

The mathematic register – according to Chapman (1993), the mathematic register describes the specialised way mathematics uses language and is most obvious in its 'highly specialised vocabulary: both words appropriated and redefined from everyday language, such as mean, obtuse and improper, and words specific to subject-area mathematics, such as hypotenuse and integer.'

Three Reads – is a flexible framework for directing students' attention to the various aspects of the word problem each time it is read. The framework can be adjusted to suit the word problem and the students' numeracy and English language proficiency. The first read focuses on the context of the word problem and its language, concepts and assumed background knowledge. The second read identifies the mathematics in the word problem, while the final read focuses on the plan to solve the word problem.

Evidence base

There is a growing body of research (González-Calero, Berciano and Arnau 2020, Perso 2016, Swan 2018 and Whiteford 2010) which points to the particular learning needs of EAL/D learners in numeracy. The Aboriginal and Torres Strait Islander Mathematics Alliance and 8 ways of learning orient mathematics and numeracy teaching to 'bring out the maths in culture'. Halliday and Hasan (1985) discuss the need for explicit teaching of the 'mathematical register', an approach supported by CESE's research into EAL/D effective school practices. This teacher guide is also informed by

new research in effective strategies for the teaching of mathematics and numeracy (Askew 2011, Boaler 2018 and Siemon, Beswick, Brady, Clark, Faragher and Warren 2020) and aligns with Multicultural Education policy statements and Multicultural Plan 2019-2022 (PDF 1804 KB) targets.

Alignment to system priorities and/or needs: Aligns with strategic priority to improve literacy and numeracy, aligns with Our Plan for Public Education, aligns with What works best – EAL/D, aligns with Multicultural Education policy statements and Multicultural Plan 2019-2022 (PDF 1804 KB) targets.

Alignment to School Excellence Framework: Learning: Curriculum; Teaching: Effective classroom practice; Teaching: Professional standards

Alignment to Australian Professional Standards for Teachers: 1.3; 1.5; 2.5; 3.2; 5.1

Comments and feedback: Comments, feedback and suggestions for improvement, please email eald.education@det.nsw.edu.au, citing the name of the resource.

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