

## Written Numeracy Assessment in the Early Years: the challenges of pronouns and noun groups

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### **Abstract**

*We examine the challenges of pronouns and noun groups in the Australian Curriculum, Assessment and Reporting Authority's (ACARA) Year 3 National Assessment Program - Literacy and Numeracy (NAPLAN) Numeracy Example Test (ACARA, 2015a). Framed by discourses of Literacy as a General Capability (ACARA, 2015b) in the Australian Curriculum: Mathematics (ACARA, 2015c), the pronouns and noun groups used in the Example Test are mapped onto the Australian Curriculum: English Content Descriptions (ACARA, 2015d). The findings are that some of the pronouns and noun groups used in the Example Test are more complex than what Year 3 children are expected to achieve in the Australian Curriculum: English. We thus stress the need for early years teachers of mathematics to account for the unique mathematical register of written mathematics problems so that young children are not only prepared for high-stakes written numeracy assessments, but are also enabled as a numerically literate citizen.*

### **Introduction**

The Australian Curriculum, Assessment and Reporting Authority's (ACARA) Australian Curriculum: Mathematics (ACARA, 2015c) promotes Literacy as a General Capability, stating that 'learning in mathematics involves the use of knowledge and skills learning in other areas, particularly in English....' because 'success in any learning area depends on being able to use the significant, identifiable and distinctive literacy that is important for learning and representative of the content of that learning area' (ACARA, 2013b). The Australian Curriculum: Mathematics (ACARA, 2015c) highlights that the early years lays the foundation for learning the language of Mathematics. Mention is made of students learning 'the vocabulary associated with number, space, measurement and mathematical concepts and processes' such as 'synonyms (minus, subtract), technical terminology (digits, lowest common denominator), passive voice (If 7 is taken from 10) and common words with specific meanings in a mathematical context (angle, area)' (ACARA, 2015e). Our research extends ACARA's focus on the language of mathematics beyond vocabulary to look at the grammatical resources of pronouns and noun groups in written mathematical assessment. We determine how pronouns and noun groups are used within written mathematics assessment in the early years and when such skills are deemed as core content in the Australian Curriculum: English (ACARA, 2015d). We thus examine the National Assessment Program – Literacy and Numeracy (NAPLAN) Year 3 Numeracy Example Test (ACARA, 2015a). NAPLAN is an Australian-wide compulsory written numeracy assessment designed to assess a Year Three student's ability in 'Number; Algebra, Function and Pattern; Space; and Measurement, Chance and Data' (aged approximately eight years) (Ministerial Council for Education, Early Childhood Development and Youth Affairs [MCECDYA], 2010, p. 24). The documents supporting the implementation of NAPLAN are often used as content in early childhood classrooms.

## **The Language Demands of Written Mathematics Problems**

Since Monroe and Englehart's seminal (1931) work, the consensus amongst educators and researchers is that mathematics makes unique language demands not accounted for in everyday language use (see Chapman, 1997; Leach & Bowling, 2000; Abel & Exley, 2008). In her analysis of written mathematics problems in the primary years, Doyle (2007) notes that the language of mathematics is 'the means by which one can actively participate in the process of problem solving, make sense of the problem, and ultimately unlock a solution' (p. 246). In an attempt to tease out the troublesome aspects of mathematics teaching and learning for primary school students, Grimm's (2008) research found that reading comprehension had a strong relationship with problem solving performance. Lowrie and Diezmann's (2009) Australian-based study demonstrates how students' mathematics achievements also reflect an ability to understand written tasks alongside their knowledge and skill of mathematics processes. Unsworth (2001) emphasises that students need to understand how to deconstruct and reconstruct the written mathematics language if they are to engage effectively in numeracy assessment. In their research into the language demands of middle years mathematics, Dolan, Murray and Strangman (2006) found that language-related factors have received the most attention in the assessment literature and 'difficulty understanding the language on a mathematics assessment is now understood as a potential source of construct-irrelevant variance' (p. 18).

This paper is presented in three sections: (i) the data set, (ii) technical explanations of pronouns and noun groups and links to the Australian Curriculum: English, and (iii) implications of findings for mathematics teaching.

### **The Data Set: Year Three NAPLAN Numeracy Example Test**

Data are drawn from the Year Three NAPLAN Numeracy Example Test (ACARA, 2015a). At the time of undertaking the research, the actual NAPLAN test instruments were not publically available. The 2015 Example Test presents 35 test items in a 16 page A4 downloadable booklet, and like previous iterations of NAPLAN, had black ink on a white background, this time with blue highlights. Our analysis section reproduces some Example Test items. The layout and written text are copied directly from the Example Test as per our permissions agreement with ACARA. Due to copyright requirements, we were not able to reproduce the illustrations as presented in the Example Test. Instead, we have inserted hand-drawn versions of the images that are used in the Example Test. Similar to NAPLAN, the Example Test is to be completed in 45 minutes. Children are told to use a 2B or HB pencil to shade in one answer 'bubble' for each of the 27 multiple choice questions or write a short answer into a blank box for the remaining eight items. According to the *2010 Test Administration Handbook* (MCECDYA, 2010, p. 5, emphasis in original), teachers '**may** assist a student or group of students with high-support needs' by 'reading the questions' but not reading 'the numbers or symbols within the questions'. The following instructions are directed to the teacher: 'During the Numeracy test, you **MUST NOT**: read the numbers or symbols, explain the meaning of any symbols, numbers or mathematical terms, (or) interpret any graphs or diagrams' (MCECDYA, 2010, p. 5, emphasis in original). Teachers could not 'give hints or examples, explain, paraphrase or interpret questions, .... (or) remind students about related work completed in

class...' (MCEECDYA, 2010, p. 5). The expectation is that children work independently with the teacher announcing at 20 minutes that half the time has elapsed and to remind those who have finished to check their work.

The analytical focus is on two grammatical resources used in the Example Test but not required content for Year 3 children in the Australian Curriculum: English. We subscribe to the general perspectives of the linguistic system founded in the Prague school and explicated by Halliday (1978; Halliday and Matthiessen, 2004) that when mathematical meaning becomes the social function of language, it is constituted not only by a new vocabulary, but also another (grammatical) register of the local language. Barton's (2009) observation that in English the noun group (which includes pronouns) seems to be the basic concept of the mathematical register influences our interest in pronouns and noun groups. We analyse each clause to identify the use of pronouns and noun groups, then map these resources to the Australian Curriculum: English Content Descriptions (ACARA, 2015d).

## **Data Analysis**

### ***1. Use of Pronouns***

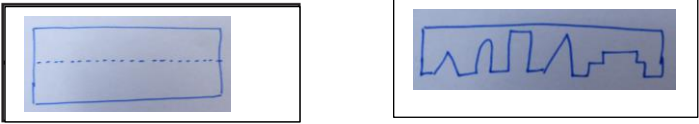
Pronouns serve a cohesive function, sustaining connections within texts that track ideas together without unnecessary repetition. Functionally, pronouns substitute or 'pick up for' (Halliday & Matthiessen, 2004, p. 67) other words. A pronoun is used in Example Test Item 5: 'Mitch has these coins. How much money does he have?'. The pronoun 'he' (sentence 2) connects to 'Mitch' (sentence 1), thus requiring the reader to make meaning from a backwards reference. On other occasions, pronouns require the reader to read forwards to make meaning. A forwards referencing pronoun is used in Example Test Item 7: 'Which of these is used to measure length?'. The pronoun 'these' only makes sense when the four illustrations are viewed: a watch, a scale, an odometer and a measuring tape.

Another complication is that pronouns serve three diverse functions: a personal reference, a possessive reference and a demonstrative reference.

- Personal pronouns are either first person (indicating the person who is speaking), for example, 'I/me/we/us', second person (indicating the person being spoken to), for example, 'you', or third person (indicating the person or thing being spoken about), for example, 'he/she/it/him/her/they/them' (Derewianka, 2011).
- Possessive pronouns indicate possession or ownership. Possessive pronouns are either first person, for example, 'mine/our', second person, for example, 'yours', or third person, for example, 'his/hers/theirs' (Derewianka, 2011). Possessive pronouns are part of the noun group rather than a direct replacement for a noun group.
- Demonstrative pronouns identify or direct attention to an object via 'this/these' for near references and 'that/those' for more distant references (Halliday & Matthiessen, 2004, p. 556). On occasion 'the' also takes on the function of a demonstrative pronoun.

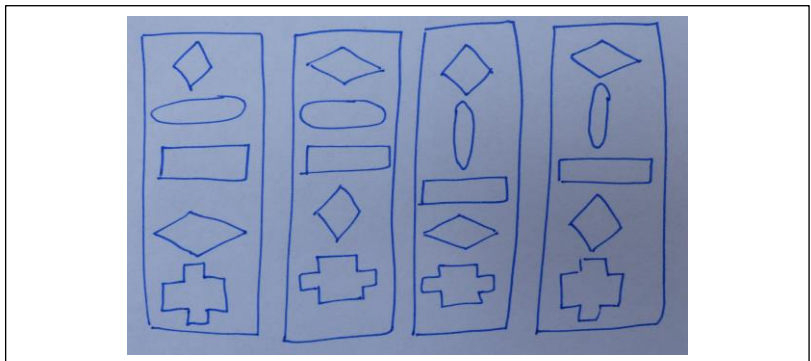
The analysis of the 35 items on the Example Test identified 37 pronouns, made up of 15 personal pronouns, 5 possessive pronouns and 17 demonstrative pronouns, spread across 23 items. Crucially, 11 items contained multiple pronouns spread across the range of pronoun types. As a case in point, we map the range of pronouns evident in Item 26 (Figure 1).

**26** Mandy folds a rectangle of paper along the dotted line and cuts out some shapes.



She unfolds the paper and turns it around.

Which of these is Mandy's paper?



**Figure 1: Question 26, NAPLAN Numeracy Year 3 Example Test (ACARA, 2015a, p. 11)**

The 3 sentences of Item 26 cover 5 clauses. Breaking sentences into clauses hones in on the single unit of meaning to show the distance pronoun references need to travel for meaning to occur. We have added [Mandy/she] in square brackets on two occasions (clauses 2 & 4) to show where a pronoun reference is structurally needed but not included in the original text. When two adjoining clauses (such as clauses 1 & 2 or clauses 3 & 4) use the same subject (in this case 'Mandy' or 'she'), the subject of the second clause is sometimes left out. The reader has to make meaning of a text where 'something that is structurally necessary is left unsaid' (Halliday & Hasan, 1976, p. 144). The missing pronoun could be 'Mandy' or 'she' hence our inclusion of both in the square brackets.

Clause 1: Mandy folds a rectangle of paper along the dotted line

Clause 2: and [Mandy/she] cuts out some shapes.

Clause 3: She unfolds the paper

Clause 4: and [Mandy/she] turns it around.

Clause 5: Which of these is Mandy's paper?

The five pronouns evident in Item 26 are as below:

- ‘She’, a third person personal pronoun at the start of clause 3 references back to ‘Mandy’ (clause 1);
- ‘it’, a third person personal pronoun in clause 4 references back to ‘paper’ (clause 3);
- ‘these’, a near reference demonstrative pronoun in clause 5 references the four diagrams that follow the written text;
- ‘she’, a third person personal pronoun that is left out of clause 2, references back to ‘Mandy’ (clause 1)
- ‘she’, a third person personal pronoun that is left out of clause 4, references back to ‘She’ (clause 3) which references back to ‘Mandy’ (clause 1).

According to the Australian Curriculum: English (ACARA, 2015d), Year 1 students ‘explore differences in words that represent people, places and things (nouns, including pronouns)...’ and Year 2 students understand that ‘there are three types of nouns: common, proper and pronouns’. Students are not solely responsible for making meaning from complex pronoun references in written texts until Year 4 when they have to ‘understand how texts are made cohesive through the use of linking devices including pronoun reference and text connectives’. The slippage between what is demanded in the Example Test and what is explicitly taught about pronoun references in Year 3 warrants attention.

## 2. Use of Noun Groups

Nouns can be built into a group of words known as a noun group (ACARA, 2015d). The head noun can be augmented with grammatical elements before the head noun: determiners (indicating ‘which?’), numerals (indicating ‘how many?’), descriptors (indicating ‘what like?’) or classifiers (indicating ‘what type?’). A qualifier can be added after the head noun to specify which thing is being talked about (Derewianka, 2011). It is not necessary for each noun group to use all of the grammatical elements (Exley & Wilson, 2012).

The analysis of the 35 items on the Example Test identified dozens of instances of noun groups with grammatical elements before the head noun. Thirteen of these noun groups are significantly more complicated as they introduce grammatical elements before and after the head noun and. Despite the centrality of the head noun, we also found 12 noun groups with the head noun missing (left out). As a case in point, Figure 2 shows Item 35 which uses four noun groups with grammatical elements before and after the head noun.

35

A movie ticket for one adult costs \$12.

A movie ticket for one child is three-quarters of the cost of an adult ticket.

What is the cost of tickets for **two** children?

\$

**Figure 2: Question 35, NAPLAN Numeracy Year 3 Example Test (ACARA, 2015a, p. 14)**

The 4 noun groups with grammatical elements before and after the head noun have been analysed in Table 1.

	determiner (indicating which?)	numeral (indicating how many?)	describers (indicating what like?)	classifiers (indicating what type?)	<b>head noun</b>	Qualifiers (specifying which thing)
1.	a			movie	ticket	for one adult
2.	a			movie	ticket	for one child
3.	the	three-quarters of			cost	of an adult ticket
4	the				cost	of tickets for two children

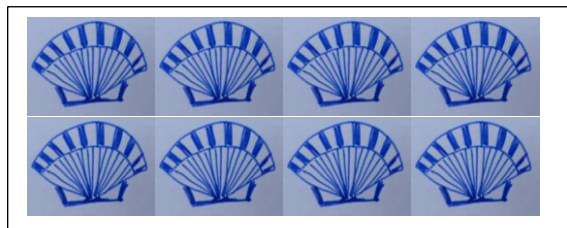
**Table 1: Analysis of Noun Groups from Question 35, NAPLAN Numeracy Year 3 Example Test**

Noun group 1 is complex because it includes grammatical elements before and after the head noun of ‘ticket’, specifying the ticket is ‘for one adult’. Noun group 2 also includes grammatical elements before and after the head noun of ‘ticket’, this time specifying the ticket is ‘for one child’. It is not until the end of a relatively long noun group that the point of difference is noted. Noun group 3 adopts the atypical structure whereby the numeral, ‘three-quarters of’ comes before the determiner ‘the’. The double-headed arrow shows the change of structure to noun group 3. Unlike the previous noun groups, the head noun this time is ‘cost’ and ‘of an adult ticket’ becomes the qualifier. Children need to hone in on the correct head noun to know that this noun group is fundamentally about the ‘cost’ rather than the ‘ticket’. Similarly, noun group 4 presents a number of viable options for the head noun; on this occasion, the head noun is ‘cost’ and ‘of tickets for two children’ is the qualifier.

On the one hand, adding elements to a noun group increases its specificity. However, on the other hand, the linguistic knowledge required to make meaning of expanded noun groups is also magnified. Not only does this analysis provide evidence of the density of noun groups across the Example Test, the problematic is that qualifiers are not explicitly taught in the Australian Curriculum: English (ACARA, 2015d) until Year Five when students should be able to ‘understand how noun and adjective groups can be expanded in a variety of ways to provide a fuller description of the person, thing or idea’.

Noun groups can also be complicated when a seemingly necessary element, such as the head noun, is left out. The analysis of the 35 items on the Example Test identified 12 noun groups where the head noun was left out. As a case in point, Figure 3 shows Item 10 where the head noun is left out of one of the noun groups in the second sentence.

10 Emma had these shells.



She kept 5 and gave the rest to Harry.  
How many shells did Emma give to Harry?

- 3                      4                      5                      8
- ☐                      ☐                      ☐                      ☐

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Figure 3: Question 10, NAPLAN Numeracy Year 3 Example Test (ACARA, 2015a, p. 5)

The truncated noun groups from the second sentence is ‘5’, as shown in the analysis in Table 2.

	determiner (indicating which?)	numeral (indicating how many?)	describers (indicating what like?)	classifiers (indicating what type?)	<b>head noun</b>	Qualifiers (specifying which thing)
1.		5				

Table 2: Analysis of Noun Groups from Question 5, Sentence 2, NAPLAN Numeracy Year 3 Example Test

Notable by its absence is the head noun. The head noun of ‘shells’ is left out. The reader has to make meaning of a text where ‘something that is structurally necessary is left unsaid’ (Halliday & Hasan, 1976, p. 144). Such a skill is not a focus of the Year 3 Australian Curriculum: English (ACARA, 2015d); by the end of Year Six students should be able to ‘understand that cohesive links can be made in texts by omitting or replacing words’ (ACARA, 2015d). Again, the slippage between what knowledge about noun groups is required to read the Example Test and what is explicitly taught about noun groups in Year 3 warrants attention.

## Discussion

This paper examines some of the grammatical challenges of reading the Example Test. The findings demonstrate that a special focus is required for pronouns references and complex noun groups. We caution policy makers and practioners who seek to alter the language of numeracy assessment. Chapman (1997) found that a shift towards the specificity of the language of mathematics is an integral part of mathematical learning. In their Australian-based research with Year Three students (aged eight years), English and Watters (2005) found that attempts to water-down mathematical problems actually slowed progress, leading to the conclusion that ‘teachers need to walk a tight rope in capitalising on the familiar’ and then deliberately step away so children learn to consider ‘data themselves as objects of reflection’ (p. 72). We also refer to discussion by Luke and Woods (2007) and analysis by Exley and Singh (2011) to draw attention to the collateral effects of manipulating the disciplinary field of knowledge. Instead, we promote the idea that teachers are active facilitators of classroom discourse who can help children to focus on their reflections and understandings about content (Dennen, 2004; Schoenfeld, 2002). We are motivated by teacher/researchers Parkin and Hayes (2006) who improved the mathematical literacy of middle years students by drawing attention to the peculiar grammatical structures of written mathematics problems. Understanding and identifying the grammatical elements within sentences and the relevance of the cohesive elements within and between clauses increased the students’ levels of mathematical meaning. We look forward to further research that reports on projects of this ilk in the early years context.

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