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Assessment 2 Task A: Supporting Literacy and/ or Numeracy in a Discipline

Introduction

Making meaning from texts is a difficult process, particularly for students encountering new material. Some students struggle to parse new words. Others may complete lexical parsing but misunderstand semantic content. Some students can understand textual knowledge but not its application. Newman's error analysis (1977) demonstrates that a number of students remain stuck at these stages, all prerequisite to processing the presented information in a text.

Students need scaffolding to learn new, unknown knowledge, here the contents of the text. (Vygotsky, 1978). We scaffold students through supporting activities, emphasised by Graduate Teaching Standards 2.5: Literacy and Numeracy Strategies as important teaching elements. This paper demonstrates Standard 2.5.1: "Know and understand literacy and numeracy teaching strategies and their application in teaching areas." (*Teacher Standards*, 2017, p. 13).

In this paper, I explore three activities that scaffold a mathematics handout regarding algebraic expressions after analysing its reading demands. The first introduces the material ("Before"). Secondly, I cover what the students will do while reading the text ("During"). Finally, I consider how the students can engage with the text they have finished reading ("After").

Term 2

My discipline is Mathematics. For the following two weeks, I will be covering Numbers and Algebra for Stage 4. The desired syllabus outcomes are that a student "generalises number properties to operate with algebraic expressions" (MA4-8NA, Board of Studies NSW, 2012, p. 284), which comprises their ability to "Extend and apply the distributive law to the expansion of algebraic expressions" (ACMNA190, ACARA, 2012), "Factorise algebraic expressions by identifying numerical factors" (ACMNA19, ACARA, 2012) and "Simplify algebraic expressions involving the four operations". (ACMNA192, ACARA, 2012). For this particular lesson, the goal is that students be able to define and provide examples of different terms associated with algebraic expressions and equations, such as polynomial, identity, like terms, constant, etcetera.

Overview

I have chosen a review sheet of terms and concepts used when discussing algebraic expressions. It gives the students a quick overview of concepts in the topic and can be referred to readily. This serves as an introduction to algebraic expressions, which are particularly important, given that algebra is central to several other topics in both Stage 4 and Stage 5.

The difficulty of this text lies in its density of vocabulary. The text introduces many terms that will be new to the students, developing disciplinary literacy in algebra. (Shanahan & Shanahan, 2012). There is a low degree of repetition of information, as is common in mathematics. Many mathematical texts are linguistically dense, often offering a challenge to their readability. (Çetinkaya et al, 2018). However, this text does provide examples of all new definitions, which facilitates comprehension.

Selected text

Vedantu. (2020, October 10). CBSE Class 8 Maths Revision Notes Chapter 9 - Algebraic Expressions and Identities. https://www.vedantu.com/revision-notes/cbse-class-8-maths-notes-chapter-9

Numeracy and Literacy Analysis

Literacy

We will analyse literacy as modelled by Australian Curriculum (2018).

Concerning text knowledge, the purpose of the text as an information report is to describe concepts of algebraic expressions. (Brisk & Zhang-Wu, 2016, p. 88) The tenor is technical. (Halliday, 1985). The text is structured in dot points, suitable for definitions. Definitions are largely independent, however, several dot points refer to information gathered in others. For example, the first point's overarching statement about expressions using the terms "variables" and "constants" which are defined in the two subsequent lines.

The text largely employs a mixture of simple sentences and fragments, demanding little grammar knowledge. For example, the terminology definitions are fragments but the differentiation between an identity and an equality includes complex sentences. There are few other compound and complex sentences.

The text builds word knowledge, as it includes multiple new terms and their definitions. A few terms are homonyms of words used in other contexts, such as "identity" or "like", although "like terms"

relates to the meaning of “similar” in other contexts. The presence of homonyms will require specific focus during the lesson to avert confusion. (Zevenbergen, 2001, p. 22)

Regarding visual knowledge, the text does not include images. Minimal navigational knowledge is required, as the text follows the standard English navigation of left-to-right, top-to-bottom. This may, however, pose a problem for some of our EAL/D students, particularly since Arabic is written right-to-left and is also prevalent in South Sudan, as the Juba dialect. (Manfredi, & Petrollino, 2013). Though traditionally written in vertical columns, Mandarin has been written in horizontal rows since 1956 (Hsia, 1956). Therefore, we may expect younger generations to be familiar with this navigation.

Numeracy

Given the text is largely verbal, our analysis of numeracy by the Australian Curriculum model will be short (2018). Measurement basics arise when comparing degrees of polynomials and likeness of terms. Expansion of algebraic expressions and adding like terms fall under estimating and calculating with whole numbers. Pattern recognition is essential when factoring expressions and identities demonstrate universally true relationships between algebraic expressions. Fractions and decimals apply to the coefficients of variables and constant terms, which need not be whole numbers.

With regards to spatial reasoning, quadratic variables can be represented in terms of a square’s area and linear variables can be represented in terms of a line. This is extended material and will not be covered in this lesson, but can provide an illustrative link. Statistical information is not present in this lesson, as algebra is an abstract tool.

Teaching strategies

Before

We begin by revising concepts of algebra previously studied in Year 7. This comprises the algebraic representation of statements, pronumerals, factors, constants, etcetera. This activity provides a shared basis of knowledge and allows students greater opportunity to participate, increasing the equality of engagement. (Rose, 2016). This also exemplifies “multiple exposures”, where we revisit prior knowledge in order to build on these concepts. (HITS, 2020, p. 20). Past knowledge provides context to the text and allows students to integrate the handout’s definitions into their mental schemas. (Piaget, 1952, p. 7).

We also discuss term usage that may confuse students, such as the text using “literal” to mean pronumeral or variable. As the text lists vocabulary, I will not examine every term presented, but instead provide an overview through dissecting an example polynomial into constants, coefficients and variables. After generating an intuitive understanding through open strategy sharing, I will state that the text the students are about to read elaborates on this topic. (Hintz & Kazemi, 2014)

To provide this context to the English as Additional Language or Dialect (EAL/D) students, I will provide a bilingual glossary of the key words in the text. (Dong, 2016). This allows them to think initially in their first language, which aids their numerical fluency by reducing the cognitive load required to translate each mental step into a less familiar language. (Choi et al., 2020). I may also briefly discuss the Arabic origin of the word “algebra”, recognising the cultural heritage of our Arabic-speaking students.

During

I regard it inadvisable to assign individual reading of a dense text. To ensure that more than a few students follow the handout, students should pool knowledge and work collaboratively. (HITS, 2020, p. 18). Therefore, the reading of the text itself will be in turns, a strategy known as shared reading and convenient for the text’s structure.

As students read out dot points, we will routinely stop and question “why” or “how”. (Edwards-Grove, 2014, p. 74). For example, a discussion of basic etymology with respect to the prefix “mono” will likely aid memory more than mere injunctives to remember a monomial is “an expression containing only one term”. (Edwards-Grove et al., 2014, pp. 62-64 ; Vedantu, 2020). This activity also provides the opportunity to explain terms that have alternate meanings in non-mathematical contexts and alleviates the density of vocabulary.

As another example, deriving the identities listed in the text also displays algebraic thinking by building on prior knowledge. For instance, the identity $(x + a)(x + b) = x^2 - (a + b)x + ab$ illustrates the distributive law applying to pronumerals in the same manner it applies to numbers. This directly serves the outcome that a student “generalises number properties to operate with algebraic expressions”. (MA4-8NA, Board of Studies NSW, 2012, p. 284).

This strategy illustrates the topic's literacy, by helping the students leverage their existing vocabulary to develop intuition regarding the new terms they are encountering. It also employs reasoning skills in its literacy approach, demonstrating a likely unexpected link between literacy and numeracy, given that students do not traditionally associate English with Mathematics. This approach will also benefit EAL/D learners by illuminating the workings of English terminology in Mathematics. Seeing the class collectively consider words this way will normalise translanguaging aspects of their language acquisition. (Choi et al., 2020).

After

To elicit and share student knowledge, we will draw and fill in Frayer models for the new terminology defined in the text such as "like terms" and "polynomials", again centring the difficult part of the text. (Frayer et al., 1969). (See Appendix C for template.) Groups will complete the models on the whiteboard, allowing multiple students to call out their answers while another stands at the whiteboard and takes suggestions for parts of the model. This gives autonomy to both the student deciding what to write and the students deciding what to suggest and resembles open strategy sharing, which encourages wider contributions. (Hintz & Kazemi, 2014).

This strategy has elements of both joint construction and longer clozes. As such, I believe it will accrue similar benefits to the students. It reiterates our dissection of a polynomial earlier and draws on prior knowledge. It also allows varying degrees of participation, thus avoiding too heavy a demand on the language proficiency of EAL/D students.

I will encourage EAL/D students to participate as they can through use of what words they know. As graphical organisers, Frayer diagrams advantageously require fewer full sentences. While this will not push the EAL/D students to develop their ability to create texts, the accessible format will encourage confidence, providing high support for the challenge of learning new English terms. Given that they are likely more fluent in mathematics than English, I will also suggest they contribute to the examples and non-examples section, which call for mathematical notation.

I consider it injudicious to force EAL/D students into "pushed" language situations as this would likely result in emotional stress while being observed by their fellow students (Gibson, 2009, p. 134). As Gibson notes, attempting to construct semantic meaning from an ungrammatical sentence rather focusing on the syntax is far more likely to encourage language learning. (2009, p. 132). Secondary

school students are also known for frequent teasing when given the opportunity to pick at imperfections, which would only serve to discourage language attempts. (Hemphill et al., 2012).

This activity also serves as a recapitulation of the material learnt from the text. The learning goal is indicated by students demonstrating their understanding of the definitions and concepts.

Conclusion

All teachers aim to facilitate their students' learning, requiring they devise multifaceted strategies in pursuit of this goal. In this paper, I have outlined three activities which employ several strategies that all aid the comprehension of a mathematical text. By providing these scaffolds in the lesson, I ease the introduction of a more complex topic, thereby setting students up for success in further complex mathematical topics, many of which rely on algebra.

References

Board of Studies NSW (2012). Introduction – Organisation of content. *Mathematics K-10 syllabus*, pp. 4-45.

Brisk, M. & Zhang-Wu, Q. (2016). Academic Language in K–12 Contexts. In Hinkel, E. (Ed.). Handbook of Research in Second Language Teaching and Learning (pp.82-100). New York, USA: Routledge.

Çetinkaya, Gökhan & Aydogan-Yenmez, Arzu & Çelik, Tuğba & ÖZPINAR, İlknur. (2018). Readability of Texts in Secondary School Mathematics Course Books. Asian Journal of Education and Training. 4. 250-256. 10.20448/journal.522.2018.44.250.256.

Choi, J., French, M., & Ollerhead, S. (2020). Introduction to the special issue: translanguaging as a resource in teaching and learning. *Australian journal of applied linguistics*, 3(1), 1-10.

Dong, Y.R. (2016). Create a responsive learning community for ELLs. *The Mathematics Teacher*, 109(7), pp. 534-540.

Edwards-Grove, C., Anstey, M. & Bull, G. (2014). *Classroom Talk: understanding dialogue, pedagogy and practice.* PETAA. Chapter 3: "Understanding talk practices"

Frayer, D., Frederick, W. C., and Klausmeier, H. J. (1969). A Schema for Testing the Level of Cognitive Mastery. Madison, WI: Wisconsin Center for Education Research.

Gibbons, P. (2009). *English learners, academic literacy, and thinking: Learning in the challenge zone* (pp. 118-130).Heinemann. [extract] Planning talk for language and literacy

Halliday, M. A. K. (1985). *An Introduction to Functional Grammar* (1st ed.). London: Edward Arnold.

Hemphill, S. A., Tollit, M., & Kotevski, A. (2012). Rates of bullying perpetration and victimisation: a longitudinal study of secondary school students in Victoria, Australia. *Pastoral Care in Education*, 30(2), 99–112. https://doi.org/10.1080/02643944.2012.679953

High impact teaching strategies (HITS). (2020). Education and Training. https://www.education.vic.gov.au/school/teachers/teachingresources/practice/improve/Pages/hits.aspx

Hintz, Allison & Kazemi, E.. (2014). Talking About Math. *Educational Leadership.* 72. 36-40.
Hsia, T. (1956). The Language Revolution in Communist China. *Far Eastern Survey, 25*(10), 145-154. doi:10.2307/3023892
Literacy. (2018). The Australian Curriculum. https://www.australiancurriculum.edu.au/f-10-curriculum/general-capabilities/literacy/
Manfredi, S., & Petrollino, S. (2013). Juba Arabic. *The Survey of Pidgin and Creole Languages*, *3*, 54-65.
Mathematics. (2012b). The Australian Curriculum. https://www.australiancurriculum.edu.au/f-10-curriculum/mathematics/?year=11759&strand=Number+and+Algebra
Newman, N. A. (1977). An analysis of sixth-grade pupils' errors on written mathematical tasks.Victorian Institute of Educational Research Bulletin, (39), 31-43
Rose, D. (2016). PETAA Paper 202:Engaging and supporting all our students to read and learn from reading. PETAA.
Shanahan, T., & Shanahan, C. (2012). What Is Disciplinary Literacy and Why Does It Matter? *Topics in Language Disorders*, 32(1), 7–18. https://doi.org/10.1097/tld.0b013e318244557a
Teacher Standards. (2017). Australian Professional Standards for Teachers. https://www.aitsl.edu.au/docs/default-source/national-policy-framework/australian-professional-standards-for-teachers.pdf
Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
Zevenbergen, R. (2001). Mathematical literacy in the middle years. *Literacy Learning : The Middle Years*, 9(2), 21–28. https://search.informit.org/doi/10.3316/aeipt.118424 (Original work published June 2001)

Appendix A: Text (following page)

CBSE Class 8 Mathematics

Revision Notes

Chapter - 9

Algebraic Expressions and Identities

- Expressions are formed from **variables** and **constants**.
- **Constant**: A symbol having a fixed numerical value. Example: 2, ⅔, 2.1, etc.
- **Variable**: A symbol which takes various numerical values. Example: *x, y, z*, etc.
- **Algebraic Expression**: A combination of constants and variables connected by the sign +,-, × and ÷ is called an algebraic expression.
- Terms are added to form **expressions**. Terms themselves are formed as product of factors.
- Expressions that contain exactly one, two and three terms are called **monomials**, **binomials** and **trinomials** respectively. In general, any expression containing one or more terms with non-zero coefficients (and with variables having non- negative exponents) is called a **polynomial**.
- **Like** terms are formed from the same variables and the powers of these variables are the same, too. Coefficients of like terms need not be the same.
- While adding (or subtracting) polynomials, first look for like terms and add (or subtract) them, then handle the unlike terms.
- There are number of situations in which we need to multiply algebraic expressions: for example, in finding area of a rectangle, the sides of which are given as expressions.
- **Monomial**: An expression containing only one term. Example: -3, 4*x*, 3*xy* etc.
- **Binomial**: An expression containing two terms. Example: 2*x*-3, 4*x*+3*y*, *xy*-4, etc.
- **Trinomial**: An expression containing three terms. Example: $2x^2 + 3xy + 9$, 3*x*+2*y*+5z, etc.
- **Polynomial**: In general, any expression containing one or more terms with non-zero coefficients (and with variables having non-negative exponents). A polynomial may contain any number of terms, one or more than one.
- A monomial multiplied by a monomial always results in a monomial.
- While multiplying a polynomial by a monomial, we multiply every term in the polynomial by the monomial.
- In carrying out the multiplication of a polynomial by a binomial (or trinomial), we multiply term by term, i.e., every term of the polynomial is multiplied by every term in the binomial (or trinomial). Note that in such multiplication, we may get terms in the product which are like and have to be combined.
- An **identity** is an equality, which is true for all values of the variables in the equality. On the other hand, an equation is true only for certain values of its variables. An equation is not an identity.

- The following are the standard identities:
- $(a + b)^2 = a^2 + 2ab + b^2$ (I)
- $(a - b)^2 = a^2 - 2ab + b^2$ (II)
- $(a - b)(a + b) = a^2 - b^2$ (III)
- Another useful identity is $(x + a)(x + b) = x^2 - (a + b)x + ab$ (IV)
- The above four identities are useful in carrying out shares and products of algebraic expressions. They also allow easy alternative methods to calculate products of numbers and so on.
- **Coefficients**: In the term of an expression any of the factors with the sign of the term is called the coefficient of the product of the other factors.
- **Terms**: Various parts of an algebraic expression which are separated by + and - signs. Example: The expression 4*x* +5 has two terms 4*x* and 5.
  (i) **Constant Term**: A term of expression having no literal factor.
  (ii) **Like term**: The term having the same literal factors. Example 2*xy* and -4*xy* are like terms
  (iii) **Unlike term**: The terms having different literal factors. Example: *x* and 3*xy* are unlike terms.
- **Factors**: Each term in an algebraic expression is a product of one or more number(s) and/or literals. These number(s) and/or literal(s) are known as the factor of that term. A constant factor is called numerical factor, while a variable factor is known as a literal factor. The term 4*x* is the product of its factors 4 and *x*.

Appendix B: Lesson Plan Proforma

Teaching Focus

Discipline	Mathematics
Strand	Numbers and Algebra
Stage	4
Syllabus Outcome/s	A student "generalises number properties to operate with algebraic expressions" (MA4-8NA) and is able to "Extend and apply the distributive law to the expansion of algebraic expressions" (ACMNA190, ACARA, 2012), "Factorise algebraic expressions by identifying numerical factors" (ACMNA19, ACARA, 2012) and "Simplify algebraic expressions involving the four operations". (ACMNA192, ACARA, 2012).
Learning Goal	Define and provide examples of different terms associated with algebraic expressions, such as polynomial, identity, like terms, constant, etcetera.

The Text

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Text Analysis

Literacy

Text Knowledge	Purpose: description. Tenor: technical. Low cohesion with dot points, though some intratextual references
Grammar Knowledge	Mostly simple sentences and fragments. Few compound or complex sentences.
Word Knowledge	Dense with new vocabulary specific to the field of algebra. Several homonyms.
Visual Knowledge	No unusual navigation, tables or images included.

Numeracy

Using Measurement	Comparing degrees of polynomials and likeness of terms
Estimating and calculating with whole numbers	Expansion of algebraic expressions, adding like terms
Recognising and using patterns and relationships	Proving and using identities, recognising patterns when factorising expressions
Using fractions, decimals, percentages, rations and rates	Coefficients of variables and constant terms may be fractional.
Using spatial reasoning	Representation of quadratic variables as a square's area and of linear variables as a line. (extended material)
Interpreting statistical information	N/A

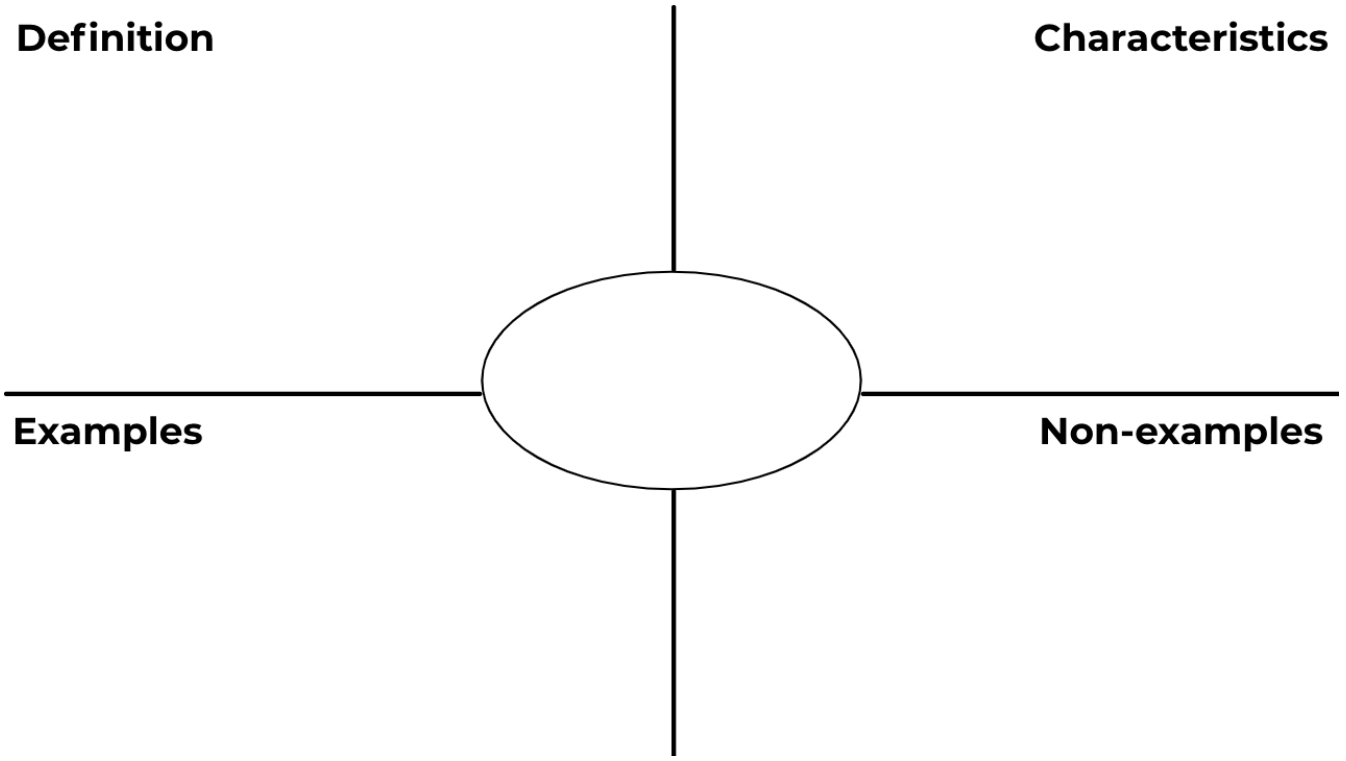
Teaching Strategy

Before	Revision of past concepts: we establish a shared knowledge base, with short examples. We then discuss unusual term usage such as the word "literal". Students identify parts of a polynomial
During	Shared reading and Wh-questions to etymologise, disambiguate homonyms and derive identities
After	Students in groups complete Frayer Models for new terminology as a joint construction of extended clozes, soliciting open strategy sharing and summarising learnings

English as Additional Language or Dialect (EAL/D)

Bilingual glossary, encouraging translanguaging, classwide etymological discussion, accessibility of Frayer models, participation through mathematical notation and teacher potentially highlighting Arabic origins of algebra for cultural appreciation

Appendix C: Frayer Model



Frayer Model Template. (2021). Kapwing. https://www.kapwing.com/explore/frayer-model-template