Mathematics Stage 4 – unit of learning – additive thinking

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## Rationale

The NSW Department of Education publishes a range of curriculum support materials, including samples of lesson sequences, scope and sequences, assessment tasks, examinations, student and teacher resource booklets, and curriculum planning and curriculum evaluation templates. The samples are not exhaustive and do not represent the only way to complete or engage in each of these processes. Curriculum design and implementation is a dynamic and contextually-specific process. While the mandatory components of syllabus implementation must be met by all schools, it is important that the approach taken by teachers is reflective of their needs and faculty/school processes.

NESA defines [programming](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming) as the process of ‘selecting and sequencing learning experiences which enable students to engage with syllabus outcomes and develop subject specific skills and knowledge’ ([NESA](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming) 2022). A program is developed collaboratively within a faculty. It differs from a unit in important ways, as outlined by NESA on their [advice on units](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming/advice-on-units) page. A unit is a contextually-specific plan for the intended teaching and learning for a particular class for a particular period. The organisation of the content in a unit is flexible and it may vary according to the school, the teacher, the class, and the learning space. They should be working documents that reflect the thoughtful planning and reflection that takes place during the teaching and learning cycle. There are mandatory components of programming and unit development, and this template provides one option for the delivery of these requirements. The NESA and department guidelines that have influenced this template are elaborated upon at the end of the document.

This resource has been developed to assist teachers in NSW Department of Education schools to create learning that is contextualised to their classroom. It can be used as a basis for the teacher’s own program, assessment, or scope and sequence, or be used as an example of how the new curriculum could be implemented. The resource has suggested timeframes that may need to be adjusted by the teacher to meet the needs of their students.

## Overview

**Description:** this program of learning addresses content from the focus areas of Computation with integers, Fractions, decimals and percentages, and Algebraic techniques. The lessons and sequences in this program of learning are designed to allow students to explore addition and subtraction of integers, fractions, and algebraic terms. A variety of visual representations are developed as tools that students can rely on within this unit and beyond.

**Duration:** this program of learning is designed to be completed over a period of approximately 5 weeks, but can be adapted to suit the school context.

**Explicit teaching:** suggested learning intentions and success criteria are available for some lessons provided. Learning intentions and success criteria are most effective when they are contextualised to meet the needs of students in the class. The examples provided in this document are generalised to demonstrate how learning intentions and success criteria could be created.

## Outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* compares, orders and calculates with integers to solve problems **MA4-INT-C-01**
* represents and operates with fractions, decimals and percentages to solve problems **MA4-FRC-C-01**
* generalises number properties to operate with algebraic expressions including expansion and factorisation **MA4-ALG-C-01**

The identified Life Skills outcomes that relate to this unit are **MALS-FRC-01** – demonstrates knowledge of fractions in everyday contexts, **MALS-DEP-01** – demonstrates knowledge of decimals and percentages in everyday contexts, **MALS-PAT-01** – recognises and applies patterns in everyday contexts, and **MALS-ADS-01** – uses strategies for addition and subtraction.

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**Prior to planning for teaching and learning, please consider the following:**

**Engagement**

* How will I provide authentic, relevant learning opportunities for students to personally connect with lesson content?
* How will I support every student to grow in independence, confidence, and self-regulation?
* How will I facilitate every student to have high expectations for themselves?
* How will I identify and provide the support each student needs to sustain their learning efforts?

**Representation**

* What are some different ways I can present content to enable every student to access and understand it?
* How will I identify and address language and/or cultural considerations that may limit access to content for students?
* How will I make lesson content and learning materials more accessible?
* How will I plan learning experiences that are relevant and challenging for the full range of students in the classroom?

**Expression**

* How will I provide multiple ways for students to respond and express what they know?
* What tools and resources can students use to demonstrate their understanding?
* How will I know every student has understood the concepts and language presented in each lesson?
* How will I monitor if every student has achieved the learning outcomes and learning growth?

## Lesson sequence and details

### Learning episode 1 – banking troubles

#### Teaching and learning activity

Students learn to add integers in the context of depositing and withdrawing or transferring money. Students model addition contexts through the use of black and red counters to model positive and negative numbers.

#### Syllabus content

* Add and subtract integers with and without the use of digital tools
* Construct a directed number sentence to model a situation
* Examine different meanings (position or operation) for the + and - signs, depending on context

**Table 1 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Banking troubles](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-01-banking-troubles.docx)  Duration: 1–2 lessons  Learning intentions   * To add integers with or without the aid of a visual representation. * To construct a directed number sentence to model a situation.   Success criteria   * I can use counters to represent positive and negative numbers. * I can use counters to add directed numbers. * I can write a directed number sentence for a given situation. | * Black and red counters (optional) * Polypad Algebra Tiles (<https://mathigon.org/polypad#algebra-tiles>) (optional) * Decks of cards * Class set of Appendix A, B and C, printed |  |

### Learning episode 2 – bonuses and penalties

#### Teaching and learning activity

Students learn to subtract integers in the context of receiving bonuses and penalties. Students explore the concept that receiving a bonus can be considered equivalent to removing a penalty. Students model contexts using black and red counters to model positive and negative numbers.

#### Syllabus content

* Add and subtract integers with and without the use of digital tools
* Construct a directed number sentence to model a situation
* Examine different meanings (position or operation) for the + and - signs, depending on context

**Table 2 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Bonuses and penalties](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-02-bonuses-and-penalties.docx)  Duration: 1–2 lessons  Learning intentions   * To subtract integers with or without the aid of a visual representation. * To construct a directed number sentence to model a situation.   Success criteria   * I can use counters to represent positive and negative numbers. * I can use counters to subtract directed numbers. * I can write a directed number sentence for a given situation. | * Set of cards from Appendix A per group of 3 students * Black and red counters (either physical or virtual from Polypad Algebra tiles (<https://mathigon.org/polypad#algebra-tiles> ), or can be hand drawn) * [*Bonuses and penalties*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-02-bonuses-and-penalties.pptx) PowerPoint. * Connect 3 playing board (or devices to access online board game) * Class set of Appendix B and C, printed * Two spinners per pair, one with the numbers 1, 2, 3, -4, -5, -6 and the second with the numbers -1, -2, -3, 4, 5, 6 |  |

### Learning episode 3 – addition of integers using vectors

#### Teaching and learning activity

In this activity, students are introduced to vectors and how to represent them using a number line. Students learn to add integers using vectors and model this on a number line.

#### Syllabus content

* Recognise and describe the direction and magnitude of integers
* Identify and represent integers on a number line
* Add and subtract integers with and without the use of digital tools
* Examine different meanings (position or operation) for the + and - signs, depending on context

**Table 3 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Addition of integers using vectors](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-03-addition-using-vectors.docx)  Duration: 1 lesson  Learning intention   * To be able to add positive and negative integers.   Success criteria   * I can represent a number as a vector on a number line. * I can represent addition of positive integers using vectors on a number line. * I can represent addition of positive and negative integers using vectors on a number line. | * Class set of Appendix A, and B, printed * [*Addition of integers using vectors*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-03-addition-using-vectors.pptx) PowerPoint * Device per pair of students (optional) |  |

### Learning episode 4 – subtraction of integers using vectors

#### Teaching and learning activity

In this activity, students learn to subtract both positive and negative integers using vectors on a number line.

#### Syllabus content

* Recognise and describe the direction and magnitude of integers
* Identify and represent integers on a number line
* Add and subtract integers with and without the use of digital tools
* Examine different meanings (position or operation) for the + and - signs, depending on context

**Table 4 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Subtraction of integers using vectors](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-04-subtraction-using-vectors.docx)  Duration: 1 lesson  Learning intention   * To be able to subtract positive and negative integers using vectors.   Success criteria   * I can represent positive and negative numbers as vectors on a number line. * I can represent subtraction of positive integers using vectors on a number line. * I can represent subtraction of negative integers using vectors on a number line. | * Two 6-sided dice: one marked B, B, B, S, S, S and the other marked F1, F2, F3, B1, B2, B3 * Number line marked from at least -7 to +7 * Class set of Appendix A, printed * One copy of Appendix B per group of 3 * [*Subtraction of integers using vectors*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-04-subtraction-using-vectors.pptx) PowerPoint |  |

### Learning episode 5 – same same

#### Teaching and learning activity

Students build understanding of how and why fractions with common denominators and like terms can be added.

#### Syllabus content

* Represent addition and subtraction of fractions with the same or unrelated denominators

**Table 5 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Same same](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-05-same-same.docx)  Duration: 1–2 lessons  Learning intention   * To be able to add and subtract fractions with the same denominator.   Success criteria   * I can represent fractions on a number line. * I can add and subtract fractions with the same denominator. | * Two dice (10-sided preferred), or online alternative ([mathigon.org/polypad#polyhedral-dice](https://mathigon.org/polypad#polyhedral-dice)) * Fraction wall sets or class set of Appendix D, printed * Class set of Appendix A, B and C, printed * [*Same same*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-05-same-same.pptx) PowerPoint |  |

### Learning episode 6 – why fractions with different denominators don’t align

#### Teaching and learning activity

Students recognise the problem that arises when comparing fractions with different denominators.

#### Syllabus content

* Represent addition and subtraction of fractions with the same or unrelated denominators
* Solve problems involving adding and subtracting fractions and mixed numbers, including finding a common denominator

**Table 6 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Why fractions with different denominators don’t align](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-06-why-fractions-with-different-denominators-dont-align.docx)  Duration: 1 lesson  Learning intention   * To understand why fractions with different denominators can’t be added in their current form.   Success criteria   * I can explain why fractions with the same denominator can be added in their current form. * I can determine if an expression involving fractions can be fully evaluated in its current form. | * Device per pair of students * One copy per pair of Appendix A, printed |  |

### Learning episode 7 – seeing double

#### Teaching and learning activity

As a first step towards adding fractions with different denominators, students first develop the skill to transform one fraction to have the same denominator as another.

#### Syllabus content

* Create fractions with the same denominator to compare their sizes
* Represent addition and subtraction of fractions with the same or unrelated denominators
* Solve problems involving adding and subtracting fractions and mixed numbers, including finding a common denominator
* Solve problems that involve subtracting a fraction from a whole number, with and without the use of digital tools

**Table 7 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Seeing double](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-07-seeing-double.docx)  Duration: 1–2 lessons  Learning intention   * To be able to add and subtract fractions when one denominator is a multiple of another.   Success criteria   * I can identify fractions where one denominator is a multiple of another. * I can add and subtract fractions where one denominator is a multiple of another. * I can use visual representations to aid in addition of fractions. | * 6-sided dice, one per student * Special dice (optional) numbered * Counters * 1 copy per pair of Appendix A, printed (each sheet to be cut in half and split between 2) * 1 copy per pair of Appendix B, printed * Class set of Appendix C and D, printed * [*Seeing double*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-07-seeing-double.pptx) PowerPoint |  |

### Learning episode 8 – how to deal with different denominators

#### Teaching and learning activity

At this point, students understand that fractions with different denominators can’t be added until the denominators are made the same. Students will explore examples where fractions do not share a common denominator and one denominator is not a multiple of another.

#### Syllabus content

* Create fractions with the same denominator to compare their sizes
* Represent addition and subtraction of fractions with the same or unrelated denominators
* Solve problems involving adding and subtracting fractions and mixed numbers, including finding a common denominator
* Solve problems that involve subtracting a fraction from a whole number, with and without the use of digital tools

**Table 8 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [How to deal with different denominators](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-08-how-to-deal-with-different-denominators.docx)  Teaching and learning activity  Duration: 1–2 lessons  Learning intention   * To be able to add and subtract fractions when the denominators do not share a common factor.   Success criteria   * I can find the lowest common denominator for 2 fractions. * I can add and subtract fractions when the denominators don’t share a common factor. * I can use visual representations to aid in addition of fractions. | * Device per pair of students * Class set of Appendix A, printed * [*How to deal with different denominators*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-08-how-to-deal-with-different-denominators.pptx) PowerPoint |  |

### Learning episode 9 – Which numbers go here?

#### Teaching and learning activity

Students investigate alternative representations for numbers, leading to algebraic expressions.

#### Syllabus content

* Identify and define an algebraic expression as an expression formed by combining numbers and algebraic symbols using arithmetic operations
* Substitute numbers into algebraic expressions and evaluate the result

**Table 9 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Which numbers go here?](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-09-which-number-goes-here.docx)  Teaching and learning activity  Duration: 1–2 lessons  Learning intentions   * To be able to write algebraic expressions. * To be able to substitute numbers into an algebraic expression and calculate the result.   Success criteria   * I can write an expression for a number that comes before or after a number in the grid. * I can write an algebraic expression for a number that comes before or after a variable in the grid. * I can substitute a number into an algebraic expression. | * Class set of Appendix A and B, printed * Grid Algebra file ‘[1 to 24 grid (no negatives)](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-4-lesson-09-1-24-grid-no-negatives-json.zip)’ * Grid Algebra file ‘[Introducing letters](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-4-lesson-09-introducing-letters-json.zip)’ |  |

### Learning episode 10 – inverse journeys

#### Teaching and learning activity

Students use mazes and Grid Algebra to explore the addition and subtraction of algebraic terms.

#### Syllabus content

* Examine and recognise that pronumerals can be used to represent one or more numerical values and when pronumerals have more than one numerical value, they may then be referred to as variables
* Represent number sentences involving unknown quantities using pronumerals

**Table 10 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Inverse journeys](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-10-inverse-journeys.docx)  Teaching and learning activity  Duration: 1–2 lessons  Learning intentions   * To understand that variables are used to represent one or more numerical values. * To identify that addition is the inverse of subtraction and vice versa.   Success criteria   * I can identify the inverse of a given number. * I can use inverses to calculate a variable’s original value. * I can informally solve one-step equations by using inverses. | * Class set of Appendix A, B and C, printed * Grid Algebra file ‘[Inverse journeys](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-4-lesson-10-inverse-journeys-json.zip)’ |  |

### Learning episode 11 – stepping through unknowns

#### Teaching and learning activity

Students use pronumerals to represent unknown distances and add like terms to simplify expressions.

#### Syllabus content

* Generalise the associative property of addition and multiplication to algebraic expressions
* Generalise the commutative property to algebraic expressions
* Identify like terms, and add and subtract them to simplify algebraic expressions
* Substitute numbers into algebraic expressions and evaluate the result
* Identify and define an algebraic expression as an expression formed by combining numbers and algebraic symbols using arithmetic operations

**Table 11 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Stepping through unknowns](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-11-stepping-through-unknowns.docx)  Teaching and learning activity  Duration: 1–2 lessons  Learning intention   * To be able to simplify algebraic expressions.   Success criteria   * I can identify like terms. * I can simplify algebraic expressions by adding and subtracting like terms. | * Copies of Appendix A – one per group of 3, printed * Class set of Appendix B, printed * Copies of Appendix C – one per pair, printed * [*Stepping through unknowns*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-11-stepping-through-unknowns.pptx) PowerPoint * Tape measure or metre ruler per group * Scissors |  |

### Learning episode 12 – laying the foundations of algebra

#### Teaching and learning activity

Students use algebra tiles to represent and simplify algebraic expressions.

#### Syllabus content

* Identify like terms, and add and subtract them to simplify algebraic expressions
* Identify and define an algebraic expression as an expression formed by combining numbers and algebraic symbols using arithmetic operations
* Generate algebraic expressions by translating descriptions and vice versa

**Table 12 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Laying the foundations of algebra](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-12-laying-the-foundations-of-algebra.docx)  Teaching and learning activity  Duration: 1–2 lessons  Learning intention   * To be able to simplify algebraic expressions.   Success criteria   * I can identify like terms. * I can represent terms using algebra tiles. * I can simplify algebraic expressions by adding and subtracting like terms. | * Copies of Appendix A – one per pair, printed * Scissors * Device per pair of students (optional) * Class set of Appendix B, C, D and E, printed * [*Laying the foundations of algebra*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s4-unit-04-lesson-12-laying-the-foundations-of-algebra.pptx) PowerPoint |  |

## References

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NESA (NSW Education Standards Authority) (2022) ‘[Programming](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming)’, *Understanding the curriculum*, NESA website, accessed 14 March 2023.

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