Patterns, rules and graphs

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| Year level  Strand(s)  Lesson length  CD Code | Year 7  Algebra/Number/Statistics  60 mins  [AC9M7A05](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-8_year-7_year-9/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7A05&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick), [AC9M7SP03](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-8_year-7_year-9/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7SP03&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick), [AC9M7N08](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-8_year-7_year-9/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7N09&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick), [AC9M7SP01](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-8_year-7_year-9/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7ST01&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick) |
| Lesson summary | In this lesson, students play games and learn about space and location, the Cartesian plane, pattern recognition and reductive reasoning by playing games and thinking. Students create algebraic equations to describe their strategy. |
| Learning intention | * We are learning to describe and identify the rule of a pattern and define it with algebraic notation * We can produce a table of valuesto represent linear visual patterns or rules * We plot linear graphs from a table of values on the Cartesian plane. |
| Success criteria | By the end of this lesson, students can:   * identify the different rules of a pattern and describe the pattern using algebra * organise data in a table of values to show a pattern with linear growth rules * use their data to plot linear graphs on the Cartesian plane and can label the graph correctly, and are able to describe their graph making explicit connections with the pattern and its data format. |
| Why are we learning about this? | If we look carefully, patterns are all around us and linear equations are the code that describe them. For instance, musicians use patterns to create rhythms and melodies when writing songs that might end up on your playlist. Even in sports, maths helps in strategising plays and improving athlete and team performances. By learning the ‘code’ that is linear functions and equations, you can unlock the skills to explore, understand and innovate in the world around you. |
| Prerequisite student knowledge and language | Students:   * create algebraic expressions to represent relationships involving one or more operation * use words or symbols to express relationships involving unknown values * evaluate an algebraic expression or equation by substitution * collect and access data using a range of digital tools and methods in response to a defined question or problem * analyse and visualise multidimensional data by selecting and using a range of interactive tools to draw conclusions and make predictions * use maps and grid references to find locations, describe routes using directional language, and interpret keys, scales and compass directions as a precursor to working on the Cartesian plane.   Definitions for linear function, linear equation, linear expression, growing patterns and the Cartesian plane can be found at [Version 9 mathematics glossary](https://v9.australiancurriculum.edu.au/downloads/learning-areas#accordion-b71b085f07-item-f1428171c5). |
| Resources | Teacher’s slides (PowerPoint)  Grid paper, rulers, pencils, erasers for each student  Dynamic graphic software e.g. GeoGebra, Wolfram (optional) |

Curriculum information

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| Achievement standard | [Students create tables of values related to algebraic expressions and formulas and describe the effect of variation.](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10?detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)  [Students represent objects two-dimensionally in different ways, describing the usefulness of these representations.](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10?detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)  [Students use coordinates to describe transformations of points in the plane.](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10?detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick) |
| Content description(s) | Students generate tables of values from visually growing patterns or the rule of a function; describe and plot these relationships on the Cartesian plane.[AC9M7A05](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7A05&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)  Students represent objects in 2 dimensions; discuss and reason about the advantages and disadvantages of different representations.[AC9M7SP01](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7SP01&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick&cdref=Elaboration)  Students describe transformations of a set of points using coordinates in the Cartesian plane, translations and reflections on an axis, and rotations about a given point.[AC9M7SP03](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-8_year-7_year-9/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7SP03&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)  Students recognise, represent and solve problems involving ratios. [AC9M7N08](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/content-description?subject-identifier=MATMATY7&content-description-code=AC9M7SP01&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick&cdref=Elaboration) |
| General capabilities  Cross-curriculum priority | **General capabilities**  Numeracy:  Number patterns and algebraic thinking (Level 7)  Positioning and locating ([Level 5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7SP01&general-capability-code=N&element-code=NM&sub-element-index=0&sub-element-code=NMPoL&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick))  Critical and Creative Thinking:   * Draw conclusions and provide reasons ([Level 5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7SP01&general-capability-code=CCT&element-code=CCTANA&sub-element-index=0&sub-element-code=CCTANAB&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * Consider alternatives ([Level 5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7SP01&general-capability-code=CCT&element-code=CCTGEN&sub-element-index=0&sub-element-code=CCTGENB&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick))   Digital Literacy:   * Acquire and collate data ([Level 5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A05&general-capability-code=DL&element-code=DLI&sub-element-index=0&sub-element-code=DLIB&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick)) * Interpret data ([Level 5](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/general-capability-snapshot?subject-identifier=MATMATY7&content-description-code=AC9M7A05&general-capability-code=DL&element-code=DLI&sub-element-index=1&sub-element-code=DLIC&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick))   Related content  Digital Technologies: [AC9TDI9P02](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-7_year-8_year-9_year-10/content-description?subject-identifier=TECTDIY78&content-description-code=AC9TDI8P02&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=0&subjects-start-index=0&view=quick) |
| Areas of challenge | Some students may:   * confuse or mix up the *x* and *y* axes; write the y-coordinate instead of the x-coordinate: (*y*, *x*) instead of (*x*, *y*) * unable to connect the negative parts of the axes compared with the positive parts of the axes * unable to connect how the coordinates represent real-world data and what that means * not connect the purpose of algebra and why letters and symbols are used to represent a relationship to investigate * think of ‘n’ as a placeholder for only one number, and not any number * confusing the order of operations and think that the ‘=’ sign symbolises equivalence and not an instruction to work out, like an operation * hold misconceptions around equations without understanding the equation is describing a relationship (*y* = *mx*+c) and when that equation varies (for example, c is missing) are unable to apply this thinking or describe it * have challenges maintaining a consistent sense of scale or have difficulty visualising and manipulating shapes and patterns either in a grid, a plane, or in their minds. |
| Strategies | [Using games](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/using-games-and-storybooks/)  [Collaborative learning](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/collaborative-learning/)  [Mathematics investigation](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/mathematics-investigation/)  [Concrete, Representational, Abstract (CRA)](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/concrete-representational-abstract-cra/) |

Lesson structure

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| Learning hook  15–20 mins | This lesson can be presented with the accompanying teacher’s slides and teaching notes, which provide further suggestions for teaching the lesson.   * To begin, inform students they will be learning by playing, an effective teaching strategy for this level, but deserves learning intentions. * Use slide 2 to inform students of the learning intention and what that might look like by the end of the lesson (success criteria). Assure students that they will be exposed to new terminology but not to be perturbed. * Students are served a teaser about the board game ‘Battleships’ (slide 3). You may have to give a brief description of the game. Ask students if they can think of reasons why they will be playing a board game in class and what it has to do with algebra. * Move to slide 4, skills check to ensure all students have been exposed to the Cartesian plane. Students are asked to draw a Cartesian plane using a pencil and ruler, and to plot various plots. Refer to the prerequisite knowledge to support or challenge the variability of students in your class. * Slide 5 provides the link to the GeoGebra lesson, [Battleship – Cartesian coordinates](https://www.geogebra.org/m/ud9bxr3q). Provide the link to students and allow them an extended period to play battleship against the computer. The game will reinforce their ability to plot coordinate pairs on the Cartesian plane. It may be worthwhile demonstrating a few turns on the screen. |
| Explore  30 mins | **Note**: further explanation, suggestions and ideas for iterations and differentiation appear in the teaching notes of the teacher’s slides.   * Slide 6 introduces the students to the idea of combining mathematics, design, and space and location. The task is to design a straight-line dot-to-dot drawing that will be ultimately mapped out on the Cartesian plane. It is recommended that students sketch their drawings freehand and are allowed to let their imaginations run free and not limited to straight-line drawings only.   Provide grid paper to every student to provide further practice in graphing skills for students, or have students use dynamic graphic software, such as GeoGebra or Wolfram another important skill for students to develop. Students must label each of their coordinates correctly. If time allows, have students list their coordinates and trade with another student. Have their partner draw their drawing according to the list provided to see if the original design can be re-created by someone else. Finished designs could be displayed in the classroom and used as a gallery walk, depending on available time.  **Differentiation** (extend): Students can use a four-quadrant plane if they are comfortable with negative numbers or use one quadrant if they would prefer to. Students may wish to draw complicated designs but mention that unfinished work could be finished at home if they would like to.   * Instruct students to copy the table shown in slide 7 into their notebooks and fill the table out by considering the expanding pattern displayed. Ask students to describe the pattern they can see in the figures in the table. Highlight the interesting differences students may use with their language to describe the figures in the table. * Slide 8 further connects students to algebraic thinking. The pattern can be described using terms and integers. By showing the students the progression of the pattern and its linear growth (outward), this linear growth can be shown using algebraic expressions to form a linear equation. * Slide 9 turns the tables. Students are to find 5 patterns that could be described as increasing or decreasing by a linear or constant amount. Try [www.visualpatterns.org](http://www.visualpatterns.org). Instruct students to draw up a table of values for each pattern as shown previously, filling it in, and then descriptively writing the rule. Then students use algebra notation to describe the relationship they have discovered in numbers and symbols. Alert students to the fact that part of this activity will be used as an assessment. * Slide 10 is the next step. Instruct students to draw up a further table of ordered pairs, rules (equations), initial values and the size of increase of each pattern. Students are to plot 3 ordered pairs from each of their linear rules, connect them with a line and label the line with the rule. Provide support for students who are require more scaffolding at this stage. You may wish to draw an example on the board.   Note: (Teachers do not need to sign up to the mini-workshop on the visual patterns website to use this content.) |
| Summary and reflection  5–10 mins | * Ask students to reflect and share what they have learnt. Have them write down the big ideas in the lesson. Encourage students to describe these big ideas using the language of maths, and make connections to visual pattern recognition, and the concept of representing pattern as mathematical sentences or equations and the connection to linear relationships. * Discuss this reflection and reiterate the main concepts as a class. * Challenge students to go out into the world and take notice of patterns and relationships that are linear. Explain that some of them may notice relationships that are not explicitly visual patterns they can see, but abstract patterns that are implied showing an increasing or decreasing linear relationships. Ask students to report back for the following class. * Note the students that connected with the content and those that found it challenging. Think of other ways you could support those students to understand the important concept behind modelling linear relationships using algebra. Ask what you now know about your students and how you can provide feedback. Consider how you might iterate this for the following lesson, Graphs: formulas and variables. |
| Assessment | The following formative assessment is suggested.  Use slide 11 as a prompt to instruct students to graph their linear rules on [GeoGebra](http://www.geogebra.org/calculator) or other similar dynamic graphing software and submit at least one screenshot. Students may hand draw their graphs. Students could submit a paper copy, if preferred. |