# Cross-Curricular Middle School Mathematics

## MAV Conference

## 2018

# Cross-Curricular Middle School Mathematics

Jennifer Kain and Andrea Demosthenous

## Skills and Attributes of a Mathematician

- Understanding
- Communication – making thinking visible
- Problem-solving
- Collaboration
- Independence & "self-auditing"
- Valuing and learning from mistakes
- Confidence to take responsible mathematical risks

## Welcome

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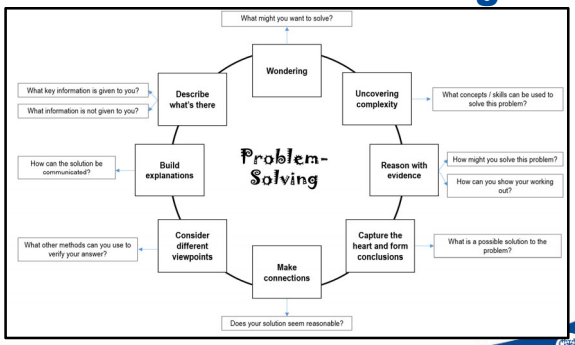
## Cultures of Thinking




Sam Capurso

## Abstract

Incorporating cross-curricular projects into the middle school Mathematics classroom can be challenging but the endeavour pays off in multiple ways. This presentation offers a glimpse into a project completed this year at Bialik College to build mathematical thinking through meaningful investigations that connect Mathematics to other subjects. The presenters will share one of their investigations, The Water Balloon Bungee, as well as a step by step process on how to incorporate these types of tasks into our fully packed curriculum. Students' reflections of the investigation will be explored, as well as the teachers' insights and goals for the next year.

## Positive Norms to Encourage in Math Class

By Jo Boaler

1. Everyone Can Learn Math to the Highest Levels. Encourage students to believe in themselves. There is no such thing as a "math" person. Everyone can reach the highest levels they want to, with hard work.

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2. Mistakes are valuable
Mistakes grow your brain! It is good to struggle and make mistakes.

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5. Math is about Connections and Communicating
Math is a connected subject, and a form of communication. Represent math in different forms eg words, a picture, a graph, an equation, and link them. Color code!

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3. Questions are Really Important
Always ask questions, always answer questions.
Ask yourself: why does that make sense?

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6. Depth is much more important than speed.
Top mathematicians, such as Laurent Schwartz, think slowly and deeply.

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7. Math Class is about Learning not Performing
Math is a growth subject, it takes time to learn and it is all about effort.

## Rank the norms

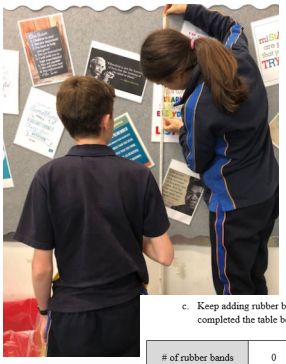
Most important to least important

## Maths Focus

- Studying linear graphs (groupings)
- Emphasis on how real life experiments can be modelled mathematically and how variation is dealt with.
- Collect data and use linear regression to model the height of the bridge.

## Focus on Connections and Depth

## Data Collection



c. Keep adding rubber bands and recording the dropped distances until you have completed the table below.

| # of rubber bands | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Distance measured (cm) | | | | | | |

## Year 8 Water Balloon Bungee

In this activity, you will create a bungee jumping simulation. The team that comes the CLOSEST to the ground without touching the ground (or breaking the balloon) will become part of the coveted Water Balloon Bungee Jumping Club.

## Testing the stretch

## Competition

(closest to the ground without touching)

## Collaborative Process

1. As a team, created idea for investigation
2. As a team, we did a test run
3. I pitched the idea to our Heads of Department and then they helped to get their teams on board.
4. Meet with interested subject teachers to plan out the cross-curricular aspects.

## Reflections

Challenging to motivate many departments to participate due to these limitations:

- Timeframe of curriculum delivery
- Content sequence
- Altering teaching styles

Worthwhile deep learning opportunity as we learned to manage our expectations.

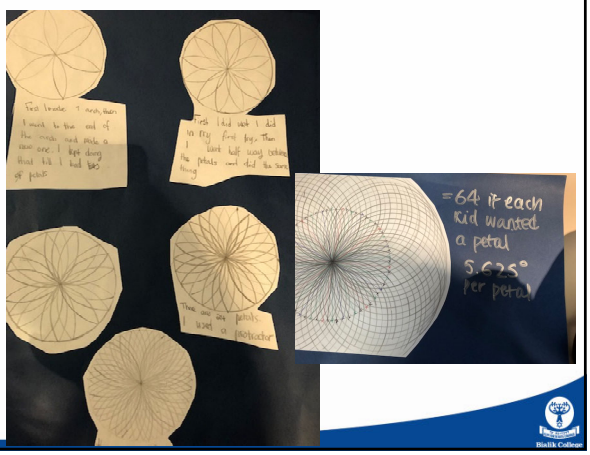
## Same Students Different Class New Connections

Science: Deeper learning opportunity for their topic of energy.
Hebrew: Report on the event like a journalist

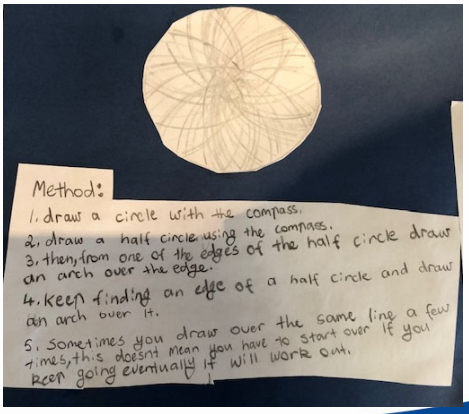
## Year 6 Cross Arts Project

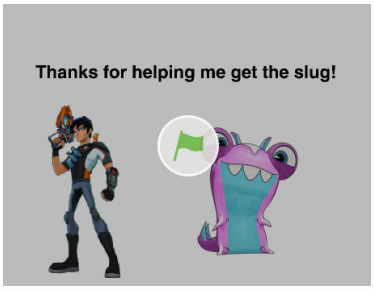
http://www.dazeddigital.com/art-photography/article/38556/1/netflix-releases-a-documentary-about-damien-hirsts-divisive-art-show

## Treasures of the Wreck of the Unbelievable




## Year 7 Scratch Project




https://scratch.mit.edu/studios/5554653/

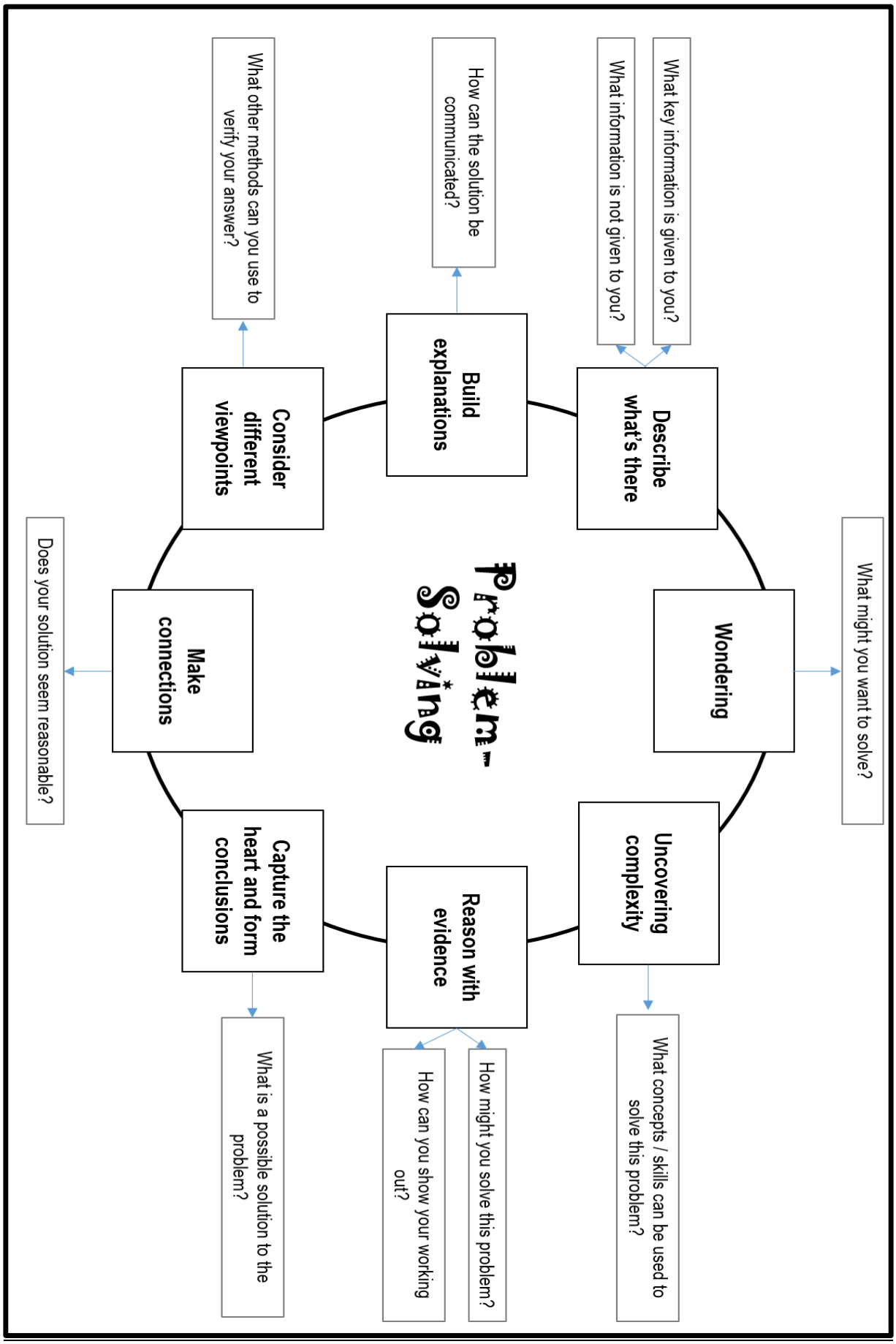
## Year 8 Micro Cooking

## 2019 & Beyond

- Plan at beginning of the year with the Science Department to sync up investigation.
- Ask students to reflect on the cross-curricular aspect and not just the mathematics learning.

## Trial Run

## Micro Cooking


Problem-Solving
Wondering
What might you want to solve?
Describe what's there
What key information is given to you?
What information is not given to you?
Build explanations
How can the solution be communicated?
Consider different viewpoints
What other methods can you use to verify your answer?
Make connections
Does your solution seem reasonable?
Capture the heart and form conclusions
What is a possible solution to the problem?
Reason with evidence
How might you solve this problem?
How can you show your working out?
Uncovering complexity
What concepts / skills can be used to solve this problem?

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Encourage students to believe in themselves. There is no such thing as a "math" person. Everyone can reach the highest levels they want to, with hard work.

2. Mistakes are valuable

Mistakes grow your brain! It is good to struggle and make mistakes.

3. Questions are Really Important

Always ask questions, always answer questions.

Ask yourself: why does that make sense?

4. Math is about Creativity and Making Sense.

Math is a very creative subject that is, at its core, about visualizing patterns and creating solution paths that others can see, discuss and critique.

5. Math is about Connections and Communicating

Math is a connected subject, and a form of communication. Represent math in different forms eg words, a picture, a graph, an equation, and link them. Color code!

6. Depth is much more important than speed.

Top mathematicians, such as Laurent Schwartz, think slowly and deeply.

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Math is a growth subject, it takes time to learn and it is all about effort.

# Chapter 4 Graphing Linear Equations

## Balloon Bungee Investigation

**AIM**: *How do we use linear models to make predictions?*

**OVERVIEW**: In this activity, you will create a bungee jumping simulation. The team that comes the CLOSEST to the ground without touching the ground (or breaking the balloon) will become part of the coveted Water Balloon Bungee Jumping Club.

With the following materials, your task will be to determine how many rubber bands it will take to drop the balloon from the bridge.

- Balloon
- Rubber bands
- Measuring tape
- Permanent marker

**Steps:**

1. To start, decorate and name your balloon. Talk to your balloon. Be nice to your balloon. **You will only get one water balloon so be careful.**

2. Collect Data:

   **a.** Choose a convenient point on the measuring tape. This will be your start point. What is your start point? _____ Hold your balloon level with the start point by the knot. Measure how far the balloon hangs down to the nearest millimetre. Record this information on the table.

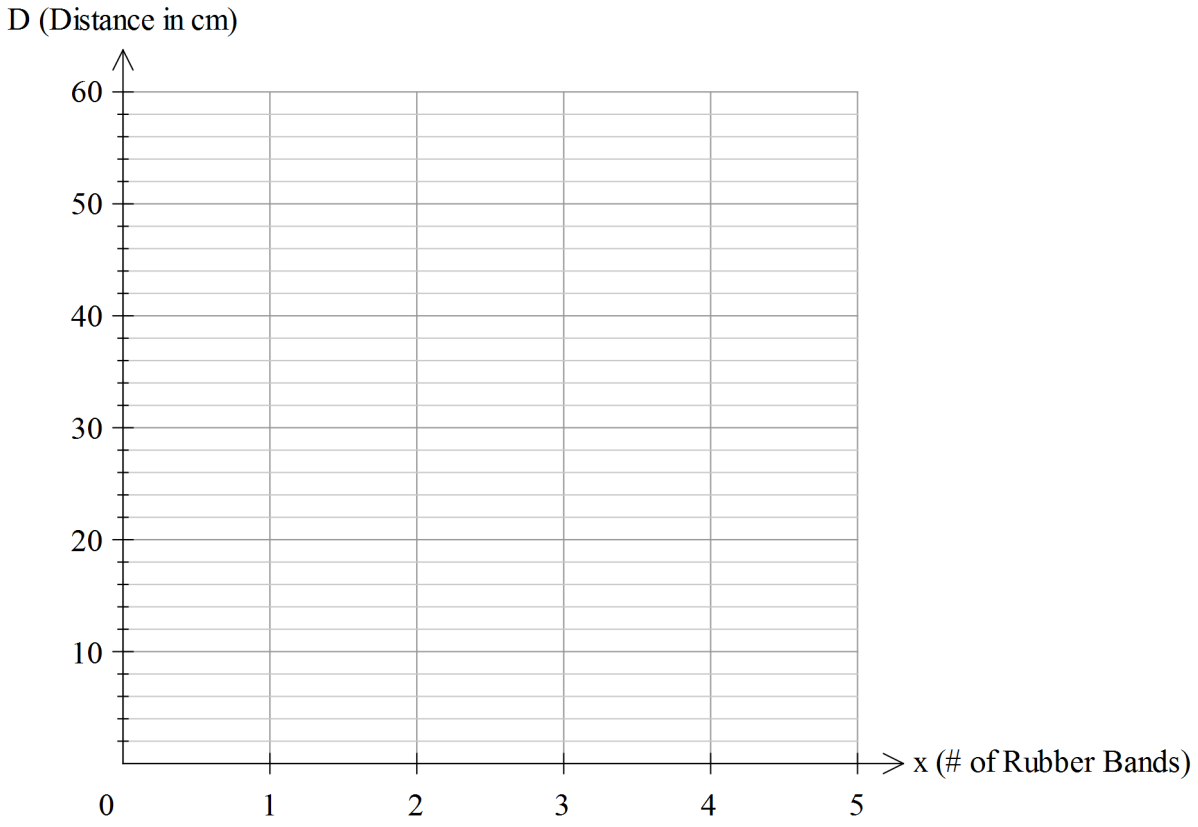
   **b.** Now attach 1 rubber band to the balloon. From your start point, **drop** the balloon from the knot making sure to hold on to the rubber band at your start point. One partner should carefully look to see how many cm (to the nearest $\frac{1}{2}$ cm) the balloon has dropped. **Be sure to measure to the furthest point it dropped.** Record this data in the table below.

c. Keep adding rubber bands and recording the dropped distances until you have completed the table below.

| # of rubber bands | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Distance measured (cm) | | | | | | |

3. In this experiment what is the independent variable and dependent variable?

4. On the graph paper below, plot the data you collected in question 2.



The process of fitting a straight line to bivariate data is known as ***linear regression.***

Linear Regression is a model of the relationship between 2 pronumerals by creating a linear equation.

5. First create a "Line of best fit" for your data by drawing a straight line through the data points. Adjust your line so that the line is balanced and approximately half of your data points are above, thru and/or below the line.

6. Calculating your gradient and $y$-intercept, write the equation of your "Line of best fit."

7. Use Excel or other graphing technology to calculate the linear regression equation.

8. Looking at your linear equation, what does your gradient mean? Write your answer in words.

9. Looking at your linear equation, what does the $y$-intercept mean? Write your answer in words.

10. You will only have 1 opportunity to drop your balloon from the bridge. How will you interpret and use your results to help you ensure your water balloon gets as close to the ground as possible but does not touch the ground? Show all thinking steps.

11. Now that you have tested your bungee cord, what were your results? What impacted the accuracy of your results?

12. Draw a flowchart to show the energy conversions which have occurred during this experiment.

13. Reflection: How does using linear equations allow us to make predictions?

# Treasures of the Wreck of the Unbelievable
# Year 6 Installation Project

Task: To create a unique sun disc that will be used to model the enlarged installation.

Using mathematics and your compass create, devise a strategy to create multiple "petals." The sun disc should have multiple "petals" so that every year 6 student can have a petal component to engrave and design.

- https://www.youtube.com/watch?v=hwfjymPx8kM
- https://www.youtube.com/watch?v=hwfjymPx8kM

Document and record with evidence:

- Annotate your Mathematical process in words or symbols
- Include multiple approaches
- Calculate the position of each petal vertex on the circle and/or the angle between each petal vertex.

Challenge: Design a sun disc with enough petal components for the whole Year 6.

# Year 7 Scratch
# Digital and Mathematics Cross Curricular Investigation

## Game Brief

Your task is to design a game that reinforces a maths concept to a year 2 student. All concepts need to relate to the topic of "location".

## Part A: Planning

Topics in this unit include:

- Compass points
- Left and Right
- Position
- Direction
- Grid references
- Atlas maps
- Mapping
- BOLTSS (border, orientation, legend, title, scale, source)
- Public transport maps

| Game Element | Game 1<br>Title:<br><br>Link/source: | Game 2<br>Title:<br><br>Link/source: | Game 3<br>Title:<br><br>Link/source: | Game 4<br>Title:<br><br>Link/source: | Game 5<br>Title:<br><br>Link/source: |
|---|---|---|---|---|---|
| **Appearance**: What is the look and feel of the game? | | | | | |
| **Challenge**: How do people win the game? Does it move through levels or do you score points? Is there more than one way to move through the game? Is the game too easy or too hard for the audience? Are there rewards in the game? | | | | | |
| **Goals**: What is the goal of the game? Is it to learn something, to entertain, to tell a story, to challenge the user to see how far they can go? | | | | | |
| **Components**: What are the different parts of the game? Are there characters and what roles do they play? Are different objects used in the game and are they | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| appropriate for the user or to meet the goal? | | | | | |
| **Mechanics**: Does the game work properly? Are the actions of the characters in the game always the same? | | | | | |
| **Instructions**: Do the instructions give you enough information to play the game successfully? Are there rules about what a component can do or not do? | | | | | |
| **Music and sound effects**: Does the game have music that supports the game? Are there sound effects for different parts of the game? Do the sound effects make sense for what is happening in the game? | | | | | |

**Conclusions:**

1. Which game was your favourite and why? Explain your answer. /2
2. Were there elements of your favourite game that you enjoyed more than others? Explain your answer. /2
3. What do you think is the most important element to get right in a game? Explain your answer. /2
4. Would your favourite game be enjoyed as much by other users? E.g. different age, different gender, different abilities, different language? Explain your answer. /2

**Topic of your game:**

1. What is the problem the game is trying to solve?:
2. Why does the problem exist?:.
3. Who is the solution for? (stakeholders):
4. Considerations for target audience:
5. List the 3 priorities of the game in order (e.g. should be fun, should teach concept, should be easy to navigate, etc.):
6. Potential issues in solving the problem: (e.g. limitations of Scratch or personal knowledge, time):

**Interview Questions for your Year 2 student:**

1. What's your name?
2. What games do you play?
3. What are your hobbies?
4. Do you know your lefts and rights?
5. What's your favourite colour?
6. What type of tech do you like?
7. What music do you like?
8. What is your favourite animal?
9. What food do you like?
10. How old are you?
11. What kind of movies do you like?
12. What do you want the game not to be about?

# Part B: Coding Journal

| Date | Goal/s for the lesson | Achievements this lesson (including screen shots) | Frustrations this lesson (including screen shots) | Goals for next lesson |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

# Part C: Assessment

**Digital Final assessment:** /40

Use your user review and self assessment, and compare this against your user needs analysis to answer the following questions:

1. Compare your finished product with your proposed solution (in your user needs analysis). What changes have occurred and why were these changes made? /4

2. Reflect on the feedback comments from your user (grade 2). What did you do well and where could improvements be made to meet their needs? /4

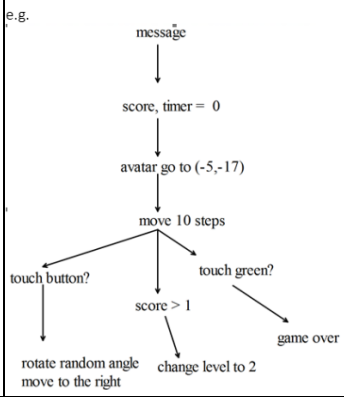
3. Reflect on the 3 priorities you set for your game (in your user needs analysis). Give yourself a mark out of 5 for each priority and explain your reasons. /12

Journal (OneNote) evaluation by teacher: up to 20 marks available

**Mathematics Final Assessment**: /21

*Marks indicate how many sentences should be in the response. Each sentence should explain a different idea or aspect.*

*Extension tasks are marked but do not contribute to overall result (i.e. are not bonus marks)*

| | | | |
|---|---|---|---|
| In your own words, what is a variable? /1 | Where in your game have you used a variable? /1 | Screen shot the code of your variable and explain how it works. /2 | How does this variable make your game better? /3 |
| In your own words, what is conditional language? /1 | Where in your game have you used conditional language? /1 | Screen shot the code of your conditional language and explain how it works. /2 | How does this conditional language make your game better? /3 |
| In your own words, what is an algorithm? /1 | Select one of your algorithms with over 10 coding blocks and put a screenshot of it here. /1 | In a flow-chart, explain how this algorithm works. Make sure you include mathematical conventions when needed. /2 e.g.   | What maths concepts underpin this algorithm. /3 |
| **Extension 1:** In your own words, what is branching? /1 | Where in your game have you used branching? /1 | Screen shot the code of your branching and explain how it works. /2 | How does this branching make your game better? /3 |
| **Extension 2:** Variables vs Broadcasts In your own words, explain the difference between a variable and a broadcast in Scratch. /3 | Where in your game have you used a variable instead of a broadcast? /1 | Screenshot your example and explain how it works. /2 | How does the use of a variable instead of a broadcast enhance your game? /3 |

# Part D: Glossary

- **Variable**: A value that can change, depending on conditions or on information passed to the program.
- **Conditional language (if/then/else)**: Part of a program that checks if a condition has been met and responds accordingly. E.g. If the score is zero, lose a life.
- **UI (user interface)**: The point where a user interacts with your program at a software (text boxes, images, buttons) and hardware level (mouse, keyboard, sounds).
- **UX (user experience)**: A user's overall experience of your program
- **Iterations/loops**: Repetition of a process or set of instructions in computer programming. Be sure to stop loops at the right time.
- **Algorithm**: A set of steps and decisions required to solve a problem. A set of algorithms is a **program**.
- **Flow charts** (include mathematical conventions, such as: coordinates, positive and negative numbers, directional degrees, greater than/less than, etc.): A visual representation of an algorithm.
- **Desk checking**: Checking the code of a program by looking at the code, rather than by running it.
- **Cartesian plane** (x/y coordinates): A graph with an X and Y axis.
- **Branching**: When an algorithm makes a choice to do one of two things or more actions based on the conditions and data provided.
- **Avatar**: An icon or image to represent a particular person in a digital environment.
- **Bitmap/Vector**: Vector graphics are created in graphics packages and consist of shapes called objects. A bitmap graphic is composed of many tiny parts, called pixels, which are often many different colours. It is possible to edit each individual pixel.
  **Differences between bitmap and vector graphics**
  The table below states the main differences between bitmap and vector graphics:
  **Comparision of bitmap and vector graphics**
- **Decompose**: Separate a complex problem into parts to allow a problem to be more easily understood.
- **Triggers** (broadcasting/keyboard/sound/action): A type of event that causes an algorithm to begin. E.g. A Scratch broadcast, a keystroke, clicking a button.
- **Intuitive**: When something is or acts as most people would expect.

# Micro Cooking Investigation

**Aim:** To use proportions accurately to measure and construct an mini oven which will cook micro food. In this task, you will then deepen your understanding of surface area and volume, continuous data and its statistical representation.

1. **Hypothesis:** Predict what impact the ratio of the surface area to volume ratio of the cooking dish will have on your cooking time and quality of your dessert.

## Part A: Preparation

Complete questions 1 to 3 before mixing any ingredients.

2. List your recipe below in its original amounts.

   Decide on an appropriate scale that you will use to scale down your recipe. List the new recipe amounts below.

3. a. Draw a sketch of your oven that you will construct. Label the actual dimensions on your diagram.

   b. Calculate the volume of the portion of your oven where the tea candle will be.

   c. Calculate the volume of the cooking space of your oven.

4. a. Draw 2 different micro cooking dishes below such that the surface area to volume ratio is different for each dish. These sketches will be the blueprints for your cooking dishes.

   Label the actual dimensions on your diagrams. Then state the ratio of the surface area to volume for each dish.

b. State your cooking time for each dish.

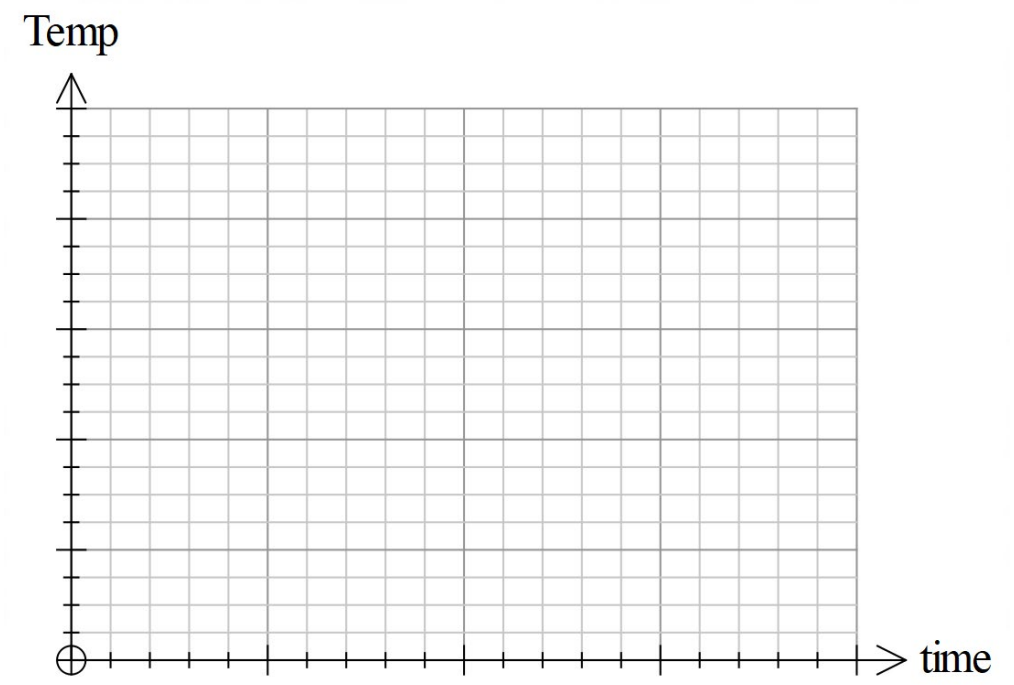
**Part B: Cooking**

Complete questions 4 to 6 while cooking your recipe.

5. Preparing your oven: Your oven needs to allow enough oxygen to keep your candle lit. Explain by writing a paragraph below your scientific method for how you will allow oxygen while having minimal heat loss.

6. Collecting Data: Using a temperature gun, graph the internal temperature change of your oven over time. Using intervals of 30 seconds, graph this data below.

| Time (in sec) | 0 | 30 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temp (in $^{o}C$) | | | | | | | | | |




7. Based on your data, what is the maximum heat capacity of your oven? Explain in words, what you could change about your construction to make the oven more efficient.

**Part C: Post Cooking**

Complete questions 7 to 8 while cooking your recipe.

8. What impact did the ratio of the surface area to volume ratio have on your cooking time and quality of your dessert?

9. If this experiment was to be extended the other way and used to prepare mega amounts of food instead of micro food, give 3 considerations that you would need to change in your experiment method.