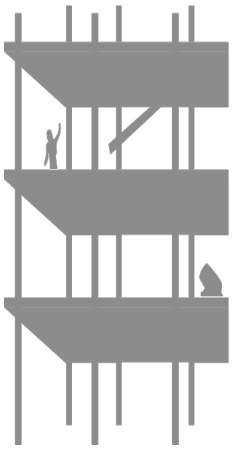


Assessment Materials for Multiplicative Thinking

Assessment Task Booklet Option 2

GROWING Mathematically

Based on the *Scaffolding Numeracy in the Middle Years* and *Reframing Mathematical Futures II* Research projects

ASSESSING MULTIPLICATIVE THINKING

ASSESSMENT TASK BOOKLET FOR MULTIPLICATIVE THINKING
OPTION 2

NAME
YEAR LEVEL:

This booklet contains 6 tasks, an Extended Task and 5 Supplementary or Short Tasks:

X1 - Butterfly House
S1 - Tables and Chairs
S2 - Packing Pots
S3 - Speedy Snail
S4 - Adventure Camp
S5 - Canteen Capers

INSTRUCTIONS:

1. Please do as much of each task as you can.
2. All working must be shown in this booklet. If you need more space, please use the back of the page, but make sure we know where to find your answer.
3. When you are asked to **show all your working and explain your answer in as much detail as possible** or to **explain your reasoning using as much mathematics as you can** or **show all your working so we can understand your thinking** do your best to write down what you did and why, in the space provided.
4. If you have any questions please ask your teacher.

BUTTERFLY HOUSE…

Some children visited the Butterfly House at the Zoo.
They learnt that a butterfly is made up of 4 wings, one body and two feelers.

While they were there, they made models and answered some questions.

For each question, explain your working and your answer, in as much detail as possible.

a. How many wings, bodies and feelers would be needed for 7 model butterflies?

_____ wings

_____ bodies

_____ feelers

b. How many complete model butterflies could you make with 16 wings, 4 bodies and 8 feelers?

c. How many wings, bodies and feelers will be needed to make 98 model butterflies. **Show all your working and explain your answer in as much detail as possible.**

_____ wings

_____ bodies

_____ feelers

d. How many complete model butterflies could you make with 29 wings, 8 bodies and 13 feelers? **Show all your working and explain your answer in as much detail as possible.**

e. To feed 2 butterflies the zoo needs 5 drops of nectar per day. How many drops would they need each day for 12 butterflies? **Show all your working and explain your answer in as much detail as possible.**

f. How many butterflies could you feed with 55 drops of nectar per day? **Show all your working and explain your answer in as much detail as possible.**

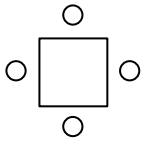
g. How many butterflies could you feed with 135 drops of nectar per day? **Show all your working and explain your answer in as much detail as possible.**

h. Model butterflies can be made with wings, grey, brown or black bodies and either long or short feelers. How many different model butterflies are possible? **Show all your working and explain your answer in as much detail as possible.**

i. In addition to either grey, brown or black bodies and either long or short feelers, model butterflies can also be made with either all yellow, all blue or all red wings. How many different model butterflies can be made now? **Show all your working and explain your answer in as much detail as possible.**

TABLES AND CHAIRS …

Dean's community is planning a street party. They have lots of small square tables.
Each table seats 4 people like this:



The community decides to put the tables in an end-to-end line along the street to make one big table.

a. Make or draw a line with 2 tables. How many people will be able to sit at it?

b. Make or draw a line of 4 tables. How many people will be able to sit at it?

c. Make or draw a line of tables that would seat 8 people. How many tables are needed?

d. Make or draw a line of tables that would seat 12 people. How many tables are needed?

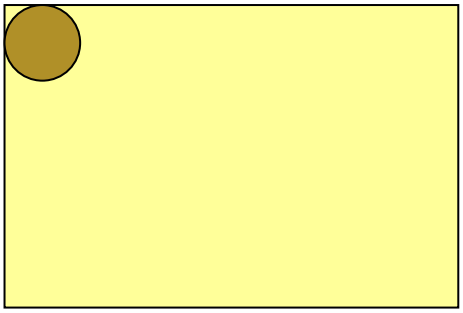
e. Make or draw a line of tables that would seat 20 people. How many tables are needed?

PACKING POTS

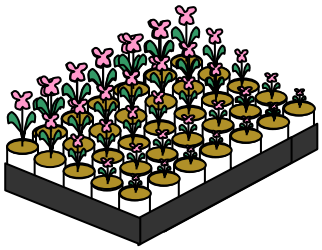
Jim works in a plant nursery.
He has been asked to put all the small pot plants into trays to take to the market.

For each question, show all your working and explain your answer in as much detail as you can.

a. To stop the pots from moving around Jim packs them into the tray as tightly as possible. How many pots will he be able to fit into this tray?



b. Jim was given some black trays that each contained 35 pot plants. How many plants would be contained in 3 of these trays?



c. How many plants would be contained in 14 of the 35-pot trays?

d. If Jim had 560 plants, how many of the 35-pot trays would he need?

SPEEDY SNAIL…

a. Harry's snail can travel at 15 centimetres per minute.
How far might Harry's snail travel in 34 minutes?

b. Samantha's snail covered 1.59 metres in 6 minutes.
How far might Samantha's snail travel in 17 minutes. Record your answer in metres.

c. Harry entered his snail in a race. Remember Harry's snail can travel at 15 centimetres per minute. Another snail entered in the same race, covered 3.71 metres in 24 minutes. Which is the faster snail?
Show all your working so we can understand your thinking.

ADVENTURE CAMP ...

Camp Reefton offers 4 activities. Everyone has a go at each activity early in the week. On Thursday afternoon students can choose the activity that they would like to do again.

The table shows how many students chose each activity at the Year 5 camp and how many chose each activity at the Year 7 camp a week later.

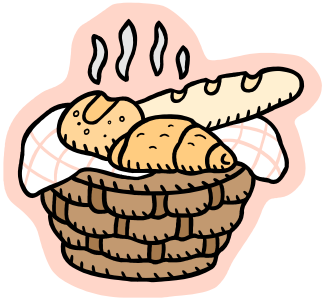
	Rock Wall	Canoeing	Archery	Ropes Course
Year 5	15	18	24	18
Year 7	19	21	38	22

Camp Reefton Thursday Activities

a. What can you say about the choices of Year 5 and Year 7 students?

b. The Camp Director said that canoeing was more popular with the Year 5 students than the Year 7 students. Do you agree with the Director's statement? **Use as much mathematics as you can to support your answer.**

CANTEEN CAPERS…



The school canteen makes great lunches. They offer 2 choices of rolls, 4 choices of filling and 3 choices of drink.

Rolls	Fillings	Drinks
White Multi-grain	Peanut butter Salad Cheese and vegemite Tuna and lettuce	Orange Juice Apple Juice Cola

For each question, show your working and explain your answer in as much detail as possible.

a. Claire ordered a peanut-butter roll and a drink. What might she have ordered? List all possibilities.

b. There are 23 students in Claire's class. If everyone ordered a roll with a filling and a drink, could they all have a different lunch order?

ASSESSING MULTIPLICATIVE THINKING

SCORING RUBRIC OPTION 2

BUTTERFLY HOUSE…		
TASK:	**RESPONSE:**	**SCORE**
a.	No response or incorrect	**0**
	Correct (28 wings, 7 bodies, 14 feelers)	**1**
b.	No response or incorrect	**0**
	Correct (4 butterflies)	**1**
c.	No response or incorrect	**0**
	Partially correct with some indication of multiplicative thinking (e.g., multiplication algorithm attempted), or correct but evidence of additive thinking (e.g., 98+98+98+98)	**1**
	All correct (392 wings, 98 bodies, 196 feelers) with evidence of multiplicative thinking, e.g., algorithm applied correctly or efficient computation strategies such as doubling or renaming (e.g., 400-8 for 4x98)	**2**
d.	No response or incorrect	**0**
	Correct (6 butterflies) but working and/or explanation indicative of additive thinking (e.g., make-all, count all strategy), or incorrect with some indication that the task has been understood in terms of multiplication or division	**1**
	Correct (6 butterflies) with clear explanation in terms of other body parts (e.g., “Can’t be 7 because not enough feelers”)	**2**
e.	No response or incorrect	**0**
	Correct (30 drops) but working and/or explanation indicates an additive approach (e.g., counts all, 5+5+5+5+5+5 or uses successive doubling strategy), or incorrect with some indication that the task has been understood in terms of multiplication or division	**1**
	Correct (30 drops) with clear explanation and/or working which indicates an appreciation of proportional relationships (e.g., “for each group of 2, zoo needs 5 drops, 6 groups of 2, so 30 drops needed”)	**2**

f.	No response or incorrect	**0**
	Correct (22 butterflies) but working and/or explanation indicates an additive approach (e.g., counts all, 5+5+5 …), or incorrect with some indication that the task has been understood in terms of multiplication or division	**1**
	Correct (22 butterflies) with clear explanation and/or working which indicates an appreciation of proportional relationships (e.g., "5 drops feed 2 butterflies, 55 is 11 times 5, so there must be 2x11 butterflies")	**2**
g.	No response or incorrect	**0**
	Correct (54 butterflies) but working and/or explanation indicates an additive approach (e.g., counts all, 5+5+5 …), or incorrect with some indication that the task has been understood in terms of multiplication or division	**1**
	Correct (54 butterflies) with clear explanation and/or working which indicates an appreciation of proportional relationships (e.g., see above)	**2**
h.	No response or incorrect	**0**
	Correct (6 butterflies) but no working and/or explanation	**1**
	Correct (6 butterflies), working and/or explanation indicates an additive approach (e.g., draws all, counts all, not particularly systematic)	**2**
	Correct (6 butterflies) with clear explanation and/or working which indicates an appreciation of Cartesian product or "for each" idea (e.g., tree diagram, systematic list)	**3**
i.	No response or incorrect	**0**
	Correct (18 butterflies) but no working and/or explanation	**1**
	Correct (18 butterflies) but working/explanation indicates an additive approach (e.g., draws all, counts all, not particularly systematic)	**2**
	Correct (18 butterflies) with clear explanation and/or working which indicates an appreciation of Cartesian product or "for each" idea (e.g., tree diagram, systematic list)	**3**

TABLES AND CHAIRS…		
TASK:	**RESPONSE:**	**SCORE**
a.	Incorrect	**0**
	Correct (6)	**1**
b.	Incorrect	**0**
	Correct (10)	**1**
c.	Incorrect	**0**
	Correct (3)	**1**
d.	Incorrect	**0**
	Correct (5)	**1**
e.	Incorrect	**0**
	Correct (9)	**1**

PACKING POTS…		
TASK:	**RESPONSE:**	**SCORE**
a.	No response or incorrect (e.g., pots drawn fairly randomly, "I just guessed")	**0**
	Incorrect, but a evidence of a systematic attempt to draw the pots as an array, or correct (24 pots), but explanation refers to counting all pots	**1**
	Correct (24 pots), drawing and/or explanation indicates that array notion has been employed and/or multiplication used to determine total (e.g., 4x6=24)	**2**
b.	No response or incorrect	**0**
	Incorrect but working and/or explanation indicates that multiplication is needed, or correct (105 pots) with little/no working and/or explanation or response indicates repeat addition or count all (e.g., "I just added", 35+35+35=105	**1**
	Correct (105 pots) working and/or explanation indicates that an efficient calculation has been used(e.g., the double and 1 more group mental strategy or 35x5=105)	**2**
c.	No response or incorrect	**0**
	Incorrect but working and/or explanation indicates that multiplication is needed, or correct (490 pots) but working and/or explanation is unclear or indicates repeat addition or the inefficient use of doubling/other strategy	**1**
	Correct (490 pots) working and/or explanation indicates that an efficient calculation has been used (e.g., a mental strategy such as "10 trays is 350, another 4 trays is 140, so 490 altogether"), or 35x14=490	**2**
d.	No response or incorrect	**0**
	Incorrect but working and/or explanation indicates that division attempted, or correct (16 trays) but working and/or explanation is unclear or indicates inefficient strategy	**1**
	Correct (16 trays) working and/or explanation indicates that an efficient calculation has been used (e.g., a mental strategy such as "35 by 10 is 350, 5 more is 175, so 15 trays will take 525, enough for 1 more tray, so 16 trays"), or 560 ÷ 35 = 16	**2**

SPEEDY SNAIL…		
TASK:	**RESPONSE:**	***SCORE***
a.	No response or incorrect with no working and/or explanation	**0**
	Incorrect but working and/or explanation indicates attempt to multiply 15 by 34, or correct (510cm or 5.1m), with evidence of additive thinking, e.g., doubling strategy or emergent multiplicative strategy (place value strategy)	**1**
	Correct (510cm or 5.1m), with explanation and/or working to indicate multiplicative reasoning (e.g., 15 by 34 solved algorithmically or using multiple of ten strategy efficiently, e.g., 10x34 and half again)	**2**
b.	No response or incorrect with little/no working and/or explanation	**0**
	Incorrect but working and/or explanation indicates appropriate attempt (e.g., to find distance travelled in 1 minute, but unclear or incomplete)	**1**
	Incorrect but some evidence of multiplicative thinking, e.g., 6 is 1.59, 12 is 3.18, 18 is 4.77, or correct (4.505 m), with little/no explanation	**2**
	Correct (4.505m), with explanation and/or working to support thinking (e.g., 0.265m/min (or equivalent) x17, or value for 18 min less I min, with answer in metres)	**3**
c.	No response or incorrect with little/no working and/or explanation	**0**
	Incorrect/incomplete but working and/or explanation recognises multiplication needed, or correct (other snail), with little/no explanation or inappropriate use of units	**1**
	Correct (other snail), with explanation and/or working to support thinking with appropriate use of units (e.g., calculate distance per minute for both snails (Harry 15cm or other snail 15.5cm), or Harry's snail's distance in comparison to the other snail, (Harry's snail 3.6m in 24min other snail 3.71m in 24 min))	**2**

ADVENTURE CAMP …		
TASK:	**RESPONSE:**	**SCORE**
a.	No response or incorrect or irrelevant statement	**0**
	One or two relatively simple observations based on numbers alone (e.g., "Archery was the most popular activity for both Year 5 and Year 7 students", "More Year 7 students liked the rock wall than Year 5 students")	**1**
	At least one observation which recognises the difference in total numbers (e.g., "Although more Year 7s actually chose the ropes course than Year 5, there were less Year 5 students, so it is hard to say")	**2**
b.	No response	**0**
	Incorrect (No), argument based on numbers alone (e.g., "There were 21 Year 7s and only 18 Year 5s")	**1**
	Correct (Yes), but little/no working or explanation to support conclusion	**2**
	Correct (Yes), working and/or explanation indicates that numbers need to be considered in relation to respective totals (e.g., "18 out of 75 is more than 21 out of 100"), but no formal use of fractions or percent or further argument to justify conclusion	**3**
	Correct (Yes), working and/or explanation uses comparable fractions or percents to justify conclusion (e.g., "For Year 7 it is 21%. For Year 5s, it is 24% because 18/75 = 6/25 = 24/100 = 24%")	**4**

CANTEEN CAPERS…		
TASK:	**RESPONSE:**	**SCORE**
a.	No response or incorrect with no working and/or explanation	**0**
	Incorrect but recognises that there is more than one option, or correct (6 options) with little/no working and/or explanation to support conclusion	**1**
	Correct (6 different options), working and/or explanation indicates answer arrived at additively (e.g., 6 options listed or drawn fairly randomly)	**2**
	Correct (6 options), working and/or explanation clearly indicates systematic approach and/or recognition of Cartesian Product idea (e.g., "It's 2 x 3 because she has 2 choices of roll and for each one she has 3 choices of drink")	**3**
b.	No response or incorrect with little/no working and/or explanation	**0**
	Correct (Yes), but little/no working or explanation to support conclusion, e.g., drawing or list not systematic, not clear that Cartesian Product idea seen as relevant	**1**
	Correct (Yes), working and/or explanation clearly supports conclusion (e.g., systematic drawing or list, and/or recognition of 24 options in terms of 2x4x3)	**2**

ASSESSING MULTIPLICATIVE THINKING

STUDENT SCORE SHEET OPTION 2

Student Name:	Year Level:

Extended Task		Score	Comments
Butterfly House	a		
	b		
	c		
	d		
	e		
	f		
	g		
	h		
	i		
Supplementary Tasks		**Score**	**Comments**
Table and Chairs	a		
	b		
	c		
	d		
	e		
Packing Pots	a		
	b		
	c		
	d		
Speedy Snail	a		
	b		
	c		
Adventure Camp	a		
	b		
Canteen Capers	a		
	b		

Total Raw Score		
LAF Level		

ASSESSING MULTIPLICATIVE THINKING

LAF Raw Score Translator Option 2

The following table is provided to enable teachers to locate students on the revised **Learning and Assessment Framework for Multiplicative Thinking 2021 (LAF)** based on their performance on Assessment Option 2 (blue font indicates revisions to the original LAF).

To use the table you will need to determine each student's total score by adding the rubric scores assigned to each item (there are 25 items altogether - 9 for Butterfly House, 5 for Tables and Chairs, 4 for Packing Pots, 3 for Speedy Snail, 2 for Adventure Camp and 2 for Canteen Capers). It is inappropriate to use the raw scores for any other purpose.

Total Score	LAF Zone	Level Description
44-48	**8**	Can use appropriate representations, language, and symbols to solve and justify a wide range of problems involving unfamiliar multiplicative situations including fractions and decimals. Can justify partitioning. Can use and formally describe patterns in terms of general rules. Beginning to work more systematically with complex, open-ended problems. Can express more complex multiplicative relationships in words or symbols in simplest form and work with two variables simultaneously and equivalent expressions. Recognises and uses scale appropriately and can use a generalised solution strategy in a new context. Beginning to recognise the relationships between perimeter, area, and volume.
37-43	**7**	Able to solve and explain one-step problems involving multiplication and division with whole numbers using informal strategies and/or formal recording. Can solve and explain solutions to problems involving simple patterns, percent, and proportion. May not be able to show working and/or explain strategies for situations involving larger numbers or less familiar problems. Locates fractions using efficient partitioning strategies. Beginning to make connections between problems and solution strategies and how to communicate this mathematically. Able to describe multiplicative relationships as rules in words or symbols but may not express this in simplest form. Can reason algebraically and use symbols to describe what is needed to maintain equivalence in an additive relational context. Can use relationships to calculate simpler volumes and explain thinking in procedural terms.
33-36	**6**	Can work with the Cartesian Product (for each) idea to systematically list or determine the number of options. Can solve a broader range of multiplication and division problems involving 2-digit numbers, patterns and/or proportion but may not be able to explain or justify solution strategy. Able to rename and compare fractions in the halving family and use partitioning strategies to locate simple fractions. Developing sense of proportion, but unable to explain or justify thinking. Developing a degree of comfort with working mentally with multiplication and division facts. Able to describe and justify rules involving multiplicative relationships Beginning to generalise patterns and formalise rules involving multiplication but may miss more complex patterns involving a constant or ratio or scales requiring estimation or use of diagonals.

30-32	**5**	Systematically solves simple proportion and array problems suggesting multiplicative thinking. May use additive thinking to solve simple proportion problems involving fractions. Able to solve simple, 2-step problems using a recognised rule/relationship but finds this difficult for larger numbers. Able to order numbers involving tens, ones, tenths and hundredths in supportive context. Able to determine all options in Cartesian product situations involving relatively small numbers but tends to do this additively. Beginning to work with decimal numbers and percent but unable to apply efficiently to solve problems. Some evidence that multiplicative thinking being used to support partitioning. Beginning to approach a broader range of multiplicative situations more systematically for instance, able to recognise and apply simple ratios to solve problems involving proportion or scale.
23-29	**4**	Solves more familiar multiplication and division problems involving two-digit numbers. Tend to rely on additive thinking, drawings and/or informal strategies to tackle problems involving larger numbers and/or decimals and less familiar situations. Tends not to explain their thinking or indicate working. Able to partition given number or quantity into equal parts and describe part formally. Beginning to work with simple proportion (e.g., uses % to describe a sample; can make a start, represent problem, but unable to complete successfully or justify their thinking). Beginning to recognise and use generalisations to solve problems but unable to explain or justify thinking. Use simple scales in straightforward situations and recognises the importance of scale in more complex contexts.
18-22	**3**	Demonstrates intuitive sense of proportion. Works with 'useful' numbers such as 2 and 5, and strategies such as doubling and halving. May list all options in a simple Cartesian product but cannot explain or justify solutions. Uses abbreviated methods for counting groups (e.g., doubling and doubling again to find 4 groups of, or repeated halving to compare simple fractions). Beginning to work with larger whole numbers and patterns but tends to rely on count all methods or additive thinking to solve problems. Can maintain equivalence across the equals sign and extend patterns but may not be able to explain or explanation relies on additive thinking. Beginning to recognise the importance of scale.
13-17	**2**	Trusts the count for groups of 2 and 5, that is, can use these numbers as units for counting, counts large collections efficiently, systematically keeps track of count, for instance, may order groups in arrays or as a list, but needs to 'see' all groups. Can share collections into equal groups. Recognises small numbers as composite units (e.g., can count equal groups, skip count by twos, threes, and fives). Can extend an additive pattern. Recognises multiplication is relevant but tends not to be able to follow this through to solution. Can list some of the options in simple Cartesian Product and chance situations. Some evidence of MT as equal groups/shares seen as entities that can be counted systematically. Beginning to recognise statistical variation and has some understanding of chance.
1-12	**1**	Can solve simple multiplication and division problems involving relatively small whole numbers, but tends to rely on drawing, models, and count-all strategies. May use skip counting (repeated addition) for groups less than 5. Can make simple observations from data given in a task and extend a simple pattern number pattern. Multiplicative thinking (MT) not really apparent as no indication that groups are perceived as composite units, dealt with systematically, or that the number of groups can be manipulated to support a more efficient calculation.