Papers

Six papers to write — and one rule: somebody else has to be able to check you

THIS BOOK BELONGS TO

Colour a badge in each time a paper is checked

The Diagonal That Isn't a Fraction
Sheets 9–13

A Drop of Pond Water
Sheets 14–18

Why the Ship Floats
Sheets 19–23

The Ramp Takes a Cut
Sheets 24–28

Whose Street Was It
Sheets 29–33

Two Numbers, Thirty Countries
Sheets 34–38

The four beats

Predict
before you know anything

Test
run it, more than once

Explain
why, and what you cannot claim

Replicate
somebody else runs it and checks you

Grown-ups: Replicate is not Repeat. Repeating means you do it again yourself, which tests whether your method is *reliable*. Replicating means somebody else does it from your written method, which tests whether your result is **real** — and whether you actually wrote down what you did. It is the engine of science, it is almost never taught in school, and it is the right thing to hand a student on their way out of elementary.

Grade 8 · six papers · 46 sheets

Repeat is not replicate

Two words that sound the same and do completely different jobs. This is the whole point of the volume.

distinguish explain

Repeat Grade 5

You do it again. Same person, same room, same equipment.

Tests whether your method is **reliable** — whether you get the same number twice.

Replicate Grade 8

Somebody else does it, from your written method, without you helping.

Tests whether the result is **real** — and whether you actually wrote down what you did.

What happened	Repeat or replicate?
You measure the same object three times and get 4.1, 4.2, 4.1	
You give your method to a classmate and they get 4.2	
You do the experiment again the next day and get the same answer	
Somebody in another class follows your write-up and gets something different	

The fourth row is the interesting one. Somebody follows your method and gets a different answer. Name **three** different things that could explain that — and only one of them is that you were wrong.

Either they made a mistake, or you did, or your method was not written clearly enough to follow. The third one is the commonest, and it is the one nobody expects.

Grown-ups: "your method was not clear enough" being the most likely explanation is genuinely how research works, and it is a humbling and useful thing to learn at thirteen.

Writing a method somebody can follow

Harder than it sounds. Practise on something you already know how to do.

write · test it on somebody

The exercise. Write instructions for something ordinary — making a sandwich, tying a shoelace, getting from your classroom to the office. Then hand it to somebody who has to follow it **exactly**, doing nothing you did not write down.

What I chose: .....

My method

Where did they get stuck?

What had you assumed they already knew?

The gaps are always things you know so well you forgot they were steps. That is exactly what goes wrong in a real method section, and it is why replication matters.

Grown-ups: this exercise is old and still the best one there is. The failure is instant, funny and completely convincing.

What a paper actually contains

Real research has a shape, and it is not the shape of a school report. Learn it now.

read note

Section	What goes in it	What must NOT go in it
Question	What you wanted to find out, in one sentence	your answer
Method	Exactly what you did, in enough detail to be followed	your results
Results	What you measured. Every reading, including the odd ones	what you think it means
Discussion	What you think it means, and **what you cannot claim**	new data
Replication	Who checked it, what they got, and whether it matched	excuses

The rule that makes it work

Results and Discussion are separate on purpose. Results are what happened — anybody reading them should be able to disagree with your interpretation and still trust your numbers.

Why does that separation matter? Suppose somebody reads your paper and thinks you drew the wrong conclusion. What can they still use?

Your data. If Results and Discussion are properly separated, somebody who disagrees with your conclusion can still build on your measurements — and that is how knowledge accumulates.

Grown-ups: the Results/Discussion separation is the single most transferable structural idea in this book, and it applies to essays and lab reports right through secondary.

Saying what you cannot claim

The rarest sentence in any piece of writing, at any age. Practise it before you need it.

judge · limit it

What the study found	What it can claim	What it cannot
Ten students who slept more scored higher		
One paper plane flew further with nose weight, in three throws		
A raisin swelled overnight in water		
Literacy and life expectancy rose together across thirty countries		

Three reasons a study cannot claim as much as it looks like it can. Name them — think about how many, how varied, and whether anything else changed.

Small samples, narrow conditions, and no control over the other variables. None of those makes a study worthless. All of them limit what it is allowed to say.

Grown-ups: naming the limits of your own work is unusual in adults and is the strongest possible Level 4 signal. It is worth praising loudly whenever it appears.

Being the one who checks

You will replicate somebody else's paper too. Doing it well is its own skill.

check report back

How to replicate somebody's work properly

1. **Follow only what is written.** If a step is missing, note it — do not fill it in from common sense.
2. **Do not ask them what they meant** until you have finished. The gap is the finding.
3. **Record what you got**, not what you expected them to get.
4. **Report kindly and precisely.** "Step 3 didn't say how long to wait" is useful. "It didn't work" is not.

Feedback	Useful or not? Why?
"It didn't work."	
"Step 3 didn't say how long to leave it, so I guessed ten minutes."	
"Your conclusion is wrong."	
"I got 3.9 where you got 4.2, using the same method."	

Rule 2 is the hard one. Why does asking them what they meant, before you finish, destroy the whole point?

Because then you are not testing the method — you are testing the person. A paper has to work without its author standing next to you, and that is exactly what you are checking.

Grown-ups: rule 2 is what real peer review does and it is counterintuitive to children, who want to be helpful. It is worth insisting on.

Safety, and what you will need

Read this once, properly. Then check what is already in the house.

check agree

Pond water and microscopes

- [ ] An adult knows where you are collecting from
- [ ] Never taste or drink a sample
- [ ] Return the water where you found it
- [ ] Wash your hands properly afterwards

Water, weights and ramps

- [ ] Nothing heavy above head height
- [ ] Nothing electrical near the water
- [ ] Clear the floor before you load a ramp
- [ ] Mop up spills immediately

Paper	What it needs	Got it?
1 · The Diagonal	squared paper, a ruler, a calculator, scissors	
2 · A Drop of Pond Water	a microscope if possible, a jar, a dropper, slides	
3 · Why the Ship Floats	a kitchen scale, a measuring jug, plasticine, a bowl	
4 · The Ramp Takes a Cut	a plank or stiff card, a spring scale or elastic band, a weight, a tape measure	
5 · Whose Street Was It	internet access for census records, and somewhere to take notes	
6 · Two Numbers, Thirty Countries	squared paper, a ruler, a calculator	

Signed: ..... Date: .....

Grown-ups: paper 2 works without a microscope — see its brief. A school will usually lend one, and it is worth asking.

How a paper is laid out

Five sheets, same order every time. The fifth one is the new one, and it needs another person.

read

Sheet	Beat	What happens
1	The brief	What the paper is about, what you need, and the four beats
2	Predict	Write it down before anything else. You cannot edit it later
3	Test	Run it, more than once, and write the method as you go
4	Explain	Why it happened — *and what you cannot claim*
5	Replicate	Somebody else runs your method and you compare

Sheet 5 needs another human being — a classmate, a sibling, a parent, anybody. That is not a nuisance in the design; it is the design. A paper that nobody has checked is not finished, and this is the last volume, so it is time to know that.

Line up your checkers now. Who could replicate each paper for you? Names, not "somebody".

Grown-ups: if time is short, the beat to protect is **Replicate**. It is the one nothing else in the eight-year sequence has done.

Your record of papers

One row per paper. The whole book on one page.

keep it up

Paper	Prediction right?	What I could not claim	Who checked it	Did it replicate?
1 The Diagonal				
2 Pond Water				
3 Ship Floats				
4 The Ramp				
5 Whose Street				
6 Thirty Countries				

At the end, look down the last column. How many replicated cleanly? And when one did not, was the problem your result or your writing?

If all six replicated first time, your methods were unusually clear. If one or two did not, you have learned the thing this volume exists to teach.

Grown-ups: a failed replication is a success for this book. The interesting question is always *which* of the three explanations from sheet 1 applied.

The Diagonal That Isn't a Fraction

Five sheets · you need squared paper, a ruler, scissors and a calculator

read it | get ready

Grade 7 told you every number is a fraction of two integers. Grade 8's very first expectation produces one that is not. The diagonal of a square with sides of 1 is √2 — you can measure it with a ruler and no fraction will ever equal it. This paper measures it, and then proves it with Pythagoras.

The four beats

Predict
How long is the diagonal of a 10 cm square?

Test
Measure five squares of different sizes and divide

Explain
Why the ratio is the same every time

Replicate
Somebody else measures and divides

Your research question, in one sentence. Not your answer — just the question.

Who will replicate this one for you? A name, and when you will ask them.

Grown-ups: squared paper, a ruler, scissors and a calculator.

Math B1.2 · B1.3 · E2.4

Write it down first

Before anything else. A prediction only counts if it exists before the evidence does.

predict say why

You draw a square with sides of exactly 10 cm and measure the diagonal. What do you get?

- [ ] about 10 cm
- [ ] about 14 cm
- [ ] about 20 cm
- [ ] exactly 15 cm

Why do you think that? One sentence. You will reread it in the Discussion.

Also predict what happens to the *ratio* of diagonal to side if you use a 20 cm square instead.

Grown-ups: resist correcting a wrong prediction here. It is worth far more left standing.

Method and results

Two jobs on one sheet: run it, and write the method precisely enough for somebody else to follow.

run it | write the method

Method the outline — add every detail you actually used

1. Draw squares with sides of 4, 6, 8, 10 and 12 cm on squared paper.
2. Measure each diagonal as accurately as your ruler allows.
3. Divide each diagonal by its side length.
4. Now check one with Pythagoras: side² + side² = diagonal². Take the square root.

What the outline leaves out that you had to decide yourself:

Results

Side (cm)	Diagonal (cm)	Diagonal ÷ side	Pythagoras says

Measure each diagonal twice and record both. Your ruler is the limit here, not your arithmetic.

Results only. Anything you think it *means* belongs on the next sheet, not this one.

Grown-ups: the "what the outline leaves out" box is the one that makes replication possible.

Math B1.2 · B1.3 · E2.4

Discussion

Why it happened. And then the sentence almost nobody writes.

reason | limit it

Every square gave roughly the same ratio, whatever its size. Explain why, using Pythagoras.

Now the hard part. $\sqrt{2}$ = 1.41421356… and the digits never repeat. Try to write it as a fraction with a denominator of 100. Then 1000. What is happening?

What I can claim

What I cannot sample size? conditions? uncontrolled things?

No fraction will ever equal it exactly — not with a bigger denominator, not ever. That is what **irrational** means: not a ratio. And it is the length of a line you just drew.

Grown-ups: the right-hand box is where Level 4 lives. Naming a limit is not weakness — it is what makes the rest believable.

Math B1.2 · B1.3 · E2.4

Hand it over

The new beat. Somebody else runs your method, without you helping, and you compare.

hand it over | compare

The rules, again. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got.

Who checked it: _____ Date: _____

	What I got	What they got
Ratio for the 10 cm square		
Ratio for the 12 cm square		
My conclusion / their conclusion		

Did it replicate? And if not — was it my result, their run, or my writing? Use the three explanations from sheet 1.

What they said was missing from my method. Write it in their words, not yours.

If their ratios are close to yours but not identical, that is not a failed replication — that is two people finding the limits of a ruler. Say so in your write-up.

Paper 1 checked. Go and colour in badge 1 on the cover.

Grown-ups: "in their words, not yours" matters — rewriting the criticism softens it, and the point is to hear it exactly. Math B1.2 · B1.3 · E2.4

A Drop of Pond Water

Five sheets · you need a microscope if you can get one, a jar, a dropper and slides

read it | get ready

Everything alive is made of cells and almost all of them are too small to see. One drop of pond water contains more living things than you will be able to count. This is the paper where you actually look — and if you cannot get a microscope, the brief has an alternative that still works.

The four beats

Predict
How many different kinds of living thing in one drop?

Test
Look at three drops from three places

Explain
Why the counts differ, and what a drop cannot tell you

Replicate
Somebody else counts the same samples

Your research question, in one sentence. Not your answer — just the question.

Who will replicate this one for you? A name, and when you will ask them.

Grown-ups: a microscope is ideal but not required — see the alternative below.

Science Strand B · A1 · Math E2.1

Write it down first

Before anything else. A prediction only counts if it exists before the evidence does.

predict | say why

You take one drop of pond water and look at it under a microscope. How many different kinds of living thing will you see?

- ☐ none — pond water is just water
- ☐ one or two
- ☐ between three and ten
- ☐ more than ten

Why do you think that? One sentence. You will reread it in the Discussion.

No microscope? Leave a jar of pond or rainwater on a windowsill for a week and compare it with a jar of tap water. Count what you can see with the naked eye, and say clearly in your method that this is what you did.

Grown-ups: resist correcting a wrong prediction here. It is worth far more left standing.

Method and results

Two jobs on one sheet: run it, and write the method precisely enough for somebody else to follow.

run it | write the method

Method the outline — add every detail you actually used

1. Collect water from three different places — a pond edge, open water, and under a leaf.
2. Put one drop of each on a slide. Same size drop each time.
3. Count the different *kinds* you can see, not the number of individuals.
4. Do a second drop from each sample and count again.

What the outline leaves out that you had to decide yourself:

Results

Sample	Drop 1: kinds	Drop 2: kinds	Anything moving?

Sketch anything you cannot name. A drawing with “unknown, about 40 µm, moved in a spiral” is real data.

Results only. Anything you think it *means* belongs on the next sheet, not this one.

Grown-ups: the "what the outline leaves out" box is the one that makes replication possible.

Discussion

Why it happened. And then the sentence almost nobody writes.

reason | limit it

Your three samples gave different counts. Give two reasons that are about the pond, and one that is about your method.

A typical cell is about 20 micrometres across. Convert that to nanometres, and work out roughly how many would fit across a human hair (about 80 µm).

What I can claim

What I cannot sample size? conditions? uncontrolled things?

One drop is a sample of a sample. Whatever you found, the pond contains far more — and the honest write-up says how big the drop was and how many you looked at.

Grown-ups: the right-hand box is where Level 4 lives. Naming a limit is not weakness — it is what makes the rest believable.

Science Strand B · A1 · Math E2.1

Hand it over

The new beat. Somebody else runs your method, without you helping, and you compare.

hand it over · compare

The rules, again. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got.

Who checked it: _____ Date: _____

	What I got	What they got
Kinds found in sample 1		
Kinds found in sample 3		
My conclusion / their conclusion		

Did it replicate? And if not — was it my result, their run, or my writing? Use the three explanations from sheet 1.

What they said was missing from my method. Write it in their words, not yours.

Counts of living things almost never replicate exactly — two people looking at the same drop see different things. That is a genuine and well-known problem in ecology, not a failure of yours.

Paper 2 checked. Go and colour in badge 2 on the cover.

Grown-ups: "in their words, not yours" matters — rewriting the criticism softens it, and the point is to hear it exactly.

Science Strand B · A1 · Math E2.1

Why the Ship Floats

Five sheets · you need a kitchen scale, a measuring jug, plasticine and a bowl

read it | get ready

Steel is eight times denser than water and steel ships float. The explanation is not clever — it is arithmetic. This paper makes you find the density of the same lump of plasticine twice: once as a ball, once as a boat.

The four beats

Predict
Will the same lump float as a ball? As a boat?

Test
Measure mass and volume both ways

Explain
Which number changed, and which did not

Replicate
Somebody else measures the same lump

Your research question, in one sentence. Not your answer — just the question.

Who will replicate this one for you? A name, and when you will ask them.

Grown-ups: a kitchen scale, a measuring jug, plasticine and a bowl of water.

Science Strand C · A1 · Math E2.3

Write it down first

Before anything else. A prediction only counts if it exists before the evidence does.

predict | say why

You roll a lump of plasticine into a tight ball and drop it in water. Then you flatten the same lump into a boat shape and float it. What happens?

- ☐ both sink
- ☐ both float
- ☐ the ball sinks and the boat floats
- ☐ the ball floats and the boat sinks

Why do you think that? One sentence. You will reread it in the Discussion.

Also predict which of the three quantities — mass, volume, density — changes when you reshape it. Only some do.

Grown-ups: resist correcting a wrong prediction here. It is worth far more left standing.

Science Strand C · A1 · Math E2.3

Method and results

Two jobs on one sheet: run it, and write the method precisely enough for somebody else to follow.

run it | write the method

Method the outline — add every detail you actually used

1. Weigh the lump of plasticine. Write the mass down.
2. As a tight ball: lower it into a measuring jug of water and record how much the level rises. That rise is its volume.
3. Work out density = mass ÷ volume. Then test whether it floats.
4. Reshape the same lump into a boat. Float it. Now measure how much water the *floating boat* displaces.

What the outline leaves out that you had to decide yourself:

Results

Shape	Mass (g)	Volume displaced (cm³)	Density (g/cm³)	Float or sink?

Use the same lump for both. Changing the amount of plasticine would make the two rows uncomparable.

Results only. Anything you think it *means* belongs on the next sheet, not this one.

Grown-ups: the "what the outline leaves out" box is the one that makes replication possible.

Discussion

Why it happened. And then the sentence almost nobody writes.

reason | limit it

The mass never changed. So which quantity did, and how does that explain the boat floating?

Water is about 1 g/cm³. Look at your two density figures and say exactly where the 1 sits between them.

What I can claim

What I cannot sample size? conditions? uncontrolled things?

The boat encloses air. Take the whole boat — plasticine and the air inside it — and its *average* density drops below 1. Crush it back into a ball and it sinks immediately.

Grown-ups: the right-hand box is where Level 4 lives. Naming a limit is not weakness — it is what makes the rest believable.

Science Strand C · A1 · Math E2.3

Hand it over

The new beat. Somebody else runs your method, without you helping, and you compare.

hand it over · compare

The rules, again. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got.

Who checked it: ..... Date: .....

	What I got	What they got
Density as a ball		
Density as a boat		
My conclusion / their conclusion		

Did it replicate? And if not — was it my result, their run, or my writing? Use the three explanations from sheet 1.

What they said was missing from my method. Write it in their words, not yours.

Displacement readings are hard to take precisely from a jug. If their volumes differ from yours by a few cm^3, note the precision of the jug in your write-up — that is the honest reason.

Paper 3 checked. Go and colour in badge 3 on the cover.

Grown-ups: "in their words, not yours" matters — rewriting the criticism softens it, and the point is to hear it exactly.

The Ramp Takes a Cut

Five sheets · you need a plank or stiff card, a weight, a spring scale or elastic band, and a tape measure

read it | get ready

A ramp lets you lift something heavy with less force. It does not give you the energy for free — you push it further instead. This paper measures both, multiplies them out, and finds the missing bit. That missing bit is called efficiency, and it is never 100%.

The four beats

Predict
Is the work done up the ramp the same as lifting straight up?

Test
Measure force and distance both ways, three times each

Explain
Where the missing energy went

Replicate
Somebody else measures the same ramp

Your research question, in one sentence. Not your answer — just the question.

Who will replicate this one for you? A name, and when you will ask them.

Grown-ups: a plank, a weight, and something to measure force with — a spring scale, or a marked elastic band.

Science Strand D · A1 · Math B2.1

Write it down first

Before anything else. A prediction only counts if it exists before the evidence does.

predict | say why

You lift a weight straight up 30 cm. Then you push the same weight 90 cm up a ramp to the same height. Which takes more **work** — force times distance?

- ☐ lifting straight up
- ☐ pushing up the ramp
- ☐ about the same
- ☐ impossible to say

Why do you think that? One sentence. You will reread it in the Discussion.

Also predict which needs more *force*. Force and work are different quantities, and this is the paper where that matters.

Grown-ups: resist correcting a wrong prediction here. It is worth far more left standing.

Method and results

Two jobs on one sheet: run it, and write the method precisely enough for somebody else to follow.

run it | write the method

Method the outline — add every detail you actually used

1. Measure the force needed to lift the weight straight up, and the height you lifted it.
2. Set the ramp so the top is exactly that same height. Measure its length along the slope.
3. Measure the force needed to pull the weight up the ramp, steadily.
4. Do each measurement three times. Then work out force × distance for both.

What the outline leaves out that you had to decide yourself:

Results

Route	Force	Distance	Work = F × d	Round

Pull steadily, not in jerks — a jerk gives a reading that is about your hand, not about the ramp.

Results only. Anything you think it *means* belongs on the next sheet, not this one.

Grown-ups: the "what the outline leaves out" box is the one that makes replication possible.

Discussion

Why it happened. And then the sentence almost nobody writes.

reason | limit it

The ramp needed less force but more distance. Compare the two amounts of work. Are they equal? If not, which is larger, and why must it be that one?

Work out efficiency: useful work out, divided by work in, times 100. Then explain in one sentence why it cannot be 100%.

What I can claim

What I cannot sample size? conditions? uncontrolled things?

The ramp is always the larger amount of work, because friction turns some of your push into heat. That loss is why no machine is ever 100% efficient — and it is the same “what was lost” question as every other system this year.

Grown-ups: the right-hand box is where Level 4 lives. Naming a limit is not weakness — it is what makes the rest believable.

Science Strand D · A1 · Math B2.1

Hand it over

The new beat. Somebody else runs your method, without you helping, and you compare.

hand it over · compare

The rules, again. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got.

Who checked it: ..... Date: .....

	What I got	What they got
Work lifting straight up		
Efficiency (%)		
My conclusion / their conclusion		

Did it replicate? And if not — was it my result, their run, or my writing? Use the three explanations from sheet 1.

What they said was missing from my method. Write it in their words, not yours.

Force readings from a spring scale vary a lot between people, because how steadily you pull matters. Expect their efficiency figure to differ from yours — and say in your write-up that this is a limit of the method, not a disagreement about physics.

Paper 4 checked. Go and colour in badge 4 on the cover.

Grown-ups: "in their words, not yours" matters — rewriting the criticism softens it, and the point is to hear it exactly.

Science Strand D · A1 · Math B2.1

Whose Street Was It

Five sheets · you need internet access for census records, and somewhere to take notes

read it | get ready

Canada's 1901 and 1911 censuses are online and free, and they list every household by name, age and occupation. This is the paper where History becomes data — you take one street, count what you find, and then discover what the census could not record.

The four beats

Predict
What will the commonest occupation on one street be?

Test
Count twenty households, then twenty more

Explain
What the census recorded, and what it could not

Replicate
Somebody else counts the same twenty households

Your research question, in one sentence. Not your answer — just the question.

Who will replicate this one for you? A name, and when you will ask them.

Grown-ups: internet access. Library and Archives Canada hosts the 1901 and 1911 census free.

History Strand B · Math D1.1 · D1.2

Write it down first

Before anything else. A prediction only counts if it exists before the evidence does.

predict | say why

You take one street in an Ontario town in 1901 and read the census. What do you expect to find?

- [ ] households much smaller than today
- [ ] households much larger than today
- [ ] children listed with occupations
- [ ] most adults in the same one or two trades

Why do you think that? One sentence. You will reread it in the Discussion.

Tick as many as you think. Then rank them: which are you most confident about, and which is a guess?

Grown-ups: resist correcting a wrong prediction here. It is worth far more left standing.

Method and results

Two jobs on one sheet: run it, and write the method precisely enough for somebody else to follow.

run it | write the method

Method the outline — add every detail you actually used

1. Choose one street in one town, in either the 1901 or 1911 census.
2. Record household size, the ages of everyone listed, and every occupation given.
3. Do the first twenty households. Then do twenty more and see whether the picture changes.
4. Note down anything the census asks that surprises you, and anything it does not ask at all.

What the outline leaves out that you had to decide yourself:

Results

Household	People in it	Youngest with an occupation	Commonest occupation

Record exactly what the record says, including spellings you think are wrong. Correcting a source is not your job here.

Results only. Anything you think it *means* belongs on the next sheet, not this one.

Grown-ups: the "what the outline leaves out" box is the one that makes replication possible.

Discussion

Why it happened. And then the sentence almost nobody writes.

reason | limit it

What does your street tell you about work, family size and childhood in this period? Use your numbers, not your impressions.

Now the gaps. Name two things about these people's lives that the census could not record — and one kind of person who might be missing from it entirely.

What I can claim

What I cannot sample size? conditions? uncontrolled things?

A census exists because a government wanted particular facts. What it asked tells you what mattered to the state; what it left out tells you something else entirely.

Grown-ups: the right-hand box is where Level 4 lives. Naming a limit is not weakness — it is what makes the rest believable.

History Strand B · Math D1.1 · D1.2

Hand it over

The new beat. Somebody else runs your method, without you helping, and you compare.

hand it over · compare

The rules, again. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got.

Who checked it: _____ Date: _____

	What I got	What they got
Commonest occupation		
Average household size		
My conclusion / their conclusion		

Did it replicate? And if not — was it my result, their run, or my writing? Use the three explanations from sheet 1.

What they said was missing from my method. Write it in their words, not yours.

Historical handwriting is genuinely hard to read, and two people transcribing the same page disagree more often than you would expect. If your figures differ, check whether you were reading the same households.

Paper 5 checked. Go and colour in badge 5 on the cover.

Grown-ups: "in their words, not yours" matters — rewriting the criticism softens it, and the point is to hear it exactly.

Two Numbers, Thirty Countries

Five sheets · you need squared paper, a ruler and a calculator

read it | get ready

This is the last paper of elementary school, and it puts the two hardest ideas of the year in the same place. Two variables, plotted against each other, showing a relationship you can see. And then the question that a scatter plot can never answer: does one of them cause the other?

The four beats

Predict
Will literacy and life expectancy move together?

Test
Collect two figures for thirty countries and plot them

Explain
Describe the relationship — and refuse to claim a cause

Replicate
Somebody else plots the same thirty countries

Your research question, in one sentence. Not your answer — just the question.

Who will replicate this one for you? A name, and when you will ask them.

Grown-ups: squared paper and a ruler. Development data is available free from the UN and the World Bank.

Math D1.1 · D1.3 · D1.5 · Geography Strand B

Write it down first

Before anything else. A prediction only counts if it exists before the evidence does.

predict | say why

You plot literacy rate against life expectancy for thirty countries. What shape will the cloud of points make?

- ☐ tilting up to the right — positive
- ☐ tilting down to the right — negative
- ☐ no tilt at all
- ☐ tightly on a straight line

Why do you think that? One sentence. You will reread it in the Discussion.

Also predict whether it will be *strong* or *weak*. Those are two separate questions and both are assessed.

Grown-ups: resist correcting a wrong prediction here. It is worth far more left standing.

Math D1.1 · D1.3 · D1.5 · Geography Strand B

Method and results

Two jobs on one sheet: run it, and write the method precisely enough for somebody else to follow.

run it | write the method

Method the outline — add every detail you actually used

1. Choose two development indicators. Literacy and life expectancy work well; so do GDP per capita and child mortality.
2. Collect both figures for thirty countries — include rich, middle-income and low-income ones.
3. Plot them. One variable along the bottom, the other up the side. Label both axes and say where each starts.
4. Do not join the dots. Each point is one country.

What the outline leaves out that you had to decide yourself:

Results

Country	Indicator 1	Indicator 2

List all thirty in your notes even though only eight rows fit here. And keep the outliers — they are the interesting ones.

Results only. Anything you think it *means* belongs on the next sheet, not this one.

Discussion

Why it happened. And then the sentence almost nobody writes.

reason | limit it

Describe the relationship using the five words: strong or weak, positive or negative, or none. Then find one country that sits well off the pattern and say what you would want to know about it.

Now the sentence this whole suite has been building towards. Does one of your two variables **cause** the other? Answer carefully, and say what evidence would be needed to know.

What I can claim

What I cannot sample size? conditions? uncontrolled things?

Almost certainly neither causes the other. Wealth, health and education move together because they all depend on each other and on a great deal else. **A scatter plot shows that two things move together and stops there** — and saying so is not a weakness in your paper. It is the best sentence in it.

Grown-ups: the right-hand box is where Level 4 lives. Naming a limit is not weakness — it is what makes the rest believable.

Math D1.1 · D1.3 · D1.5 · Geography Strand B

Hand it over

The new beat. Somebody else runs your method, without you helping, and you compare.

hand it over · compare

The rules, again. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got.

Who checked it: _____ Date: _____

	What I got	What they got
The relationship, in the five words		
The most extreme outlier		
My conclusion / their conclusion		

Did it replicate? And if not — was it my result, their run, or my writing? Use the three explanations from sheet 1.

What they said was missing from my method. Write it in their words, not yours.

If they used a different set of thirty countries, expect a different-looking cloud. That is worth writing up: which thirty you choose is part of your method, and different samples give different pictures.

Paper 6 checked. Go and colour in badge 6 on the cover.

Grown-ups: "in their words, not yours" matters — rewriting the criticism softens it, and the point is to hear it exactly.

Math D1.1 · D1.3 · D1.5 · Geography Strand B

Which ones replicated?

Go back to sheet 8 and fill in the last column. Then look down it honestly.

✓ score it diagnose

Paper	Replicated?	If not — my result, their run, or my writing?
1 The Diagonal		
2 Pond Water		
3 Ship Floats		
4 The Ramp		
5 Whose Street		
6 Thirty Countries		

Replicated cleanly: _____ out of 6

Most common reason when it did not:

Which paper's method was clearest? What did you do differently in that one?

Papers 2, 5 and 6 are the ones least likely to have replicated exactly. Look at what they have in common. Why are counting living things, reading old handwriting and choosing a sample harder to replicate than measuring a diagonal?

Because a human being has to make a judgement in the middle. Where a step needs somebody to decide something, two people decide differently — and that is true of most real research.

Grown-ups: the observation that judgement-dependent methods replicate worse is a genuinely advanced insight and is exactly why some fields have a replication problem.

All papers

Eight years, four moves

Volume 2 has been running since Grade 1. Here is everything it added, in order.

look back · name it

Grade	Called	The four beats	What it added
1–2	Missions	Predict · Explore · Record · Compare	
3	Investigations	Predict · Explore · Record · Compare	
4	Expeditions	Predict · Explore · Record · Compare	
5	Trials	Predict · Test · **Repeat** · Explain	
6	Cases	Predict · Gather · **Weigh** · Decide	
7	Studies	Predict · **Isolate** · Test · Explain	
8	Papers	Predict · Test · Explain · **Replicate**	

Four beats were added in four years: Repeat, Weigh, Isolate, Replicate. Put them in the order they have to happen in a real piece of work, and say why that is the order.

Which of the four is hardest, and why? There is no right answer here — but there is a reason for whichever you pick.

Isolate comes before you test. Repeat comes during. Weigh and Replicate come after. That is not an accident — it is the shape of every honest investigation, and you now have all four.

Grown-ups: this page is the closing argument of the whole Volume 2 sequence. A student who can order the four beats and justify it has understood eight years of method.

All grades

Paper 7 — entirely yours

Your question, your method, your limits. And somebody else has to be able to check it.

choose design

Four properties of a good final question. You can gather the evidence yourself. There is exactly one thing you would change. You do not already know the answer. And **somebody else could run it from your description.**

My question: .....

My prediction: .....

	Mine
What I will change exactly one thing	
What I will hold still at least four	
What I will measure and in what units	
How many repeats, and why that many	
Who will replicate it	

The fourth property is the new one. Read your plan back as if you had never seen it. Which step would a stranger get stuck on?

_____

_____

_____

Grown-ups: "read it as if you had never seen it" is the habit that makes a method section work, and it transfers straight to secondary lab reports.

Method and results

Write the method as you go, not afterwards. Afterwards you will leave things out.

run it | write it down

Method numbered steps, no step assumed

Results — every reading, including the odd ones

Setting	Run 1	Run 2	Run 3	Mean	Range

Graph it. Label both axes and say honestly where each one starts. Did anything you promised to hold still slip? Note it beside the graph.

Grown-ups: the Range column matters — a wide spread means the mean is not trustworthy, and that belongs in the Discussion.

Discussion, and your limits

Why it happened. And then the box that most published papers still get wrong.

reason | limit it

What happened, and why it happened

What I can claim

What I cannot

Back to your prediction. Was it right? If not, what were you assuming that turned out not to hold?

What would you change about the *method* if you ran it again? Not the question — the method.

Read your two boxes back. If the left-hand box claims more than your data supports, move a sentence across. That is not losing an argument — that is what an honest paper looks like.

Grown-ups: "move a sentence across" is a concrete revision instruction and far more useful than telling a student to be careful.

Hand it over

The last beat of the last paper of elementary school. Give it to somebody and step back.

hand it over · compare

The rules one last time. They follow only what you wrote. They do not ask you what you meant until they have finished. They record what *they* got, not what they think you wanted.

Who checked it: ..... Date: .....

	Mine	Theirs
Main result		
Spread across runs		
Conclusion		

Every step they got stuck on, in their words. Do not soften it and do not explain it away.

Now rewrite the one step that failed. Write the better version here.

That rewritten step is the most valuable thing in this book. It is the difference between work that only you can do and work that anybody can build on — and that difference is what makes something knowledge rather than an anecdote.

Grown-ups: if only one page of this volume gets done properly, make it this one. Everything else in the eight-year sequence has led here.

What you can do now

The last checklist of elementary school. Tick honestly — a blank is information.

✓ tick

- [ ] I know the difference between repeat and replicate
- [ ] I keep Results and Discussion separate
- [ ] I can say what I cannot claim
- [ ] I can replicate somebody else's work fairly
- [ ] I found $\sqrt{2}$ with a ruler
- [ ] I know where the ramp's missing energy went
- [ ] I can write a method a stranger could follow
- [ ] I record readings I did not like
- [ ] I report the spread, not just the mean
- [ ] I can take criticism of my method without defending it
- [ ] I know why the same lump of plasticine floats one way and sinks the other
- [ ] I know a scatter plot cannot show a cause

The one I am proudest of

The one I want to get better at

And one for the road. You are leaving elementary school. Which of these will you actually still be using in five years?

Rows five and eight are the rare ones. Naming the limits of your own work, and hearing a criticism of your method without arguing back, are uncommon in adults — and both are habits, not talents.

Grown-ups: this is the last checklist in the whole eight-year suite. It is worth reading through together rather than handing over.

All strands

Where the papers came from

Every paper is built on a real Grade 8 expectation. Here is which one, and how confident I am about it.

Paper	Expectation	Verified?
1 The Diagonal	Math **B1.2** — describe, compare and order numbers in the *real number system*, rational and irrational. Also **B1.3** and **E2.4**, the Pythagorean relationship.	✅ verified
2 A Drop of Pond Water	Science **Strand B — Cells**. Also Math **E2.1**, the micrometre and nanometre conversions.	✅ strand name verified · specific codes not checked
3 Why the Ship Floats	Science **Strand C — Fluids**, including density, buoyancy and displacement.	✅ strand name verified · specific codes not checked
4 The Ramp Takes a Cut	Science **Strand D — Systems in Action**, including mechanical advantage, work and efficiency.	✅ strand name verified · specific codes not checked
5 Whose Street Was It	History **Strand B — Canada, 1890–1914: A Changing Society**. Also Math **D1.1** and **D1.2**.	✅ strand name verified · specific codes not checked
6 Two Numbers, Thirty Countries	Math **D1.1**, **D1.3** and **D1.5** — two-variable data, scatter plots, and the language of relationships. Geography **Strand B**.	✅ math codes verified individually · Geography strand name verified

The mathematics codes are verified individually against the Ministry expectations chart. Science, History and Geography are verified at strand level; their specific codes were not checked one by one. **Grade 8's Science strand names had no 2007/2022 renaming discrepancy** — unlike Grades 5, 6 and 7, this is the one grade where a resource's strand name can be taken at face value.

For teachers: the Ministry's curriculum is at **dcp.edu.gov.on.ca**. The companion **Grade 8 Mathematics** book cites all 44 codes individually; the **Everything Else** book carries its own verification page.

Grown-ups: a wrong expectation code in a report card is worse than no code at all, which is why this page has appeared in every book in this suite.