# Make a paper desktop plan

FAMILY PROJECT 04 · OFTEN AGES 14–18 · READINESS FIRST

# Scale it. Solve it. Check it.

Make movable paper footprints for an imaginary desktop. Use proportion, area and an equation to explain whether the layout fits. This is a tabletop math model, not furniture construction or an ergonomic design.

**PILOT — not physically tested with families.** Directions, handling and learning outcomes are unverified. Not an engineered plan or a validated intervention.

## Parent preparation and adult roles

Work together at a clear table. Use two sheets of Letter or A4 paper, a metric ruler, pencil and optional calculator. The parent checks dimensions and handles scissors; put scissors away after cutting. No tools beyond scissors, no moving furniture, no lifting, mounting or electrical work. No purchase is needed.

**Ready?** Try explaining why 60 ÷ 10 = 6 and measuring 6 cm from zero. Model that step first if needed. Keep the ruler and worked example available. Start with the paper layout; algebra can wait. There is no timer.

## Paper preparation list

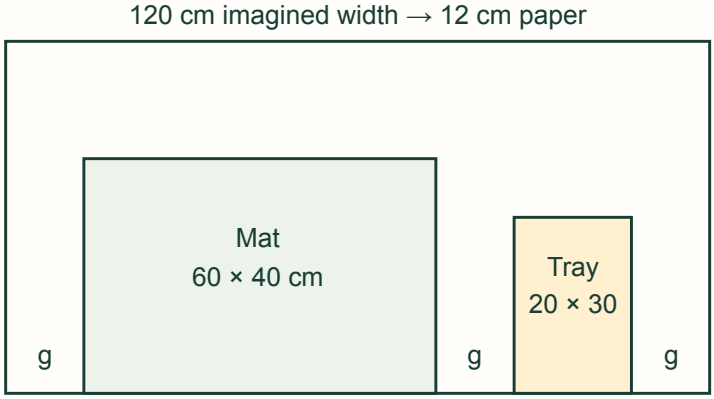
At 1:10 scale, every paper length is the real length divided by 10

| Item | Imagined real size | Paper size |
|---|---|---|
| Desktop boundary: draw, do not cut | 120 × 60 cm | 12 × 6 cm |
| Writing mat: cut one | 60 × 40 cm | 6 × 4 cm |
| Tray: cut one | 20 × 30 cm | 2 × 3 cm |

Measure and label your own rectangles. The diagrams are not full-size templates. “Real” means the imagined dimensions above, not measurements of your own furniture. Adult supervision is required.

# Build the scale model

1. Draw a 12 cm-wide by 6 cm-deep boundary. Lay it landscape. Mark its front edge. Have the adult cut the two labeled paper footprints.
2. Place the mat's 6 cm side left-to-right and its 4 cm side front-to-back. Place the tray to its right, with its 2 cm side left-to-right. Align their front edges.
3. Use a 1 cm paper gap at the left, between the objects, and at the right. Check: 1 + 6 + 1 + 2 + 1 = 11 cm. There is 1 cm of extra width, so these minimum gaps fit.
4. Now spread that extra width equally across the three gaps. Each gap becomes 1⅓ cm on paper, representing 13⅓ cm. Exact thirds are awkward on a ruler: calculate exactly, then place approximately. Label the model "approximate."




**Depth check:** 40 ≤ 60 and 30 ≤ 60. Front alignment leaves 20 cm behind the mat and 30 cm behind the tray. The three equal gaps refer only to left-to-right width, not clearance on every side.

> Ask: "Where is one paper centimeter in our imagined desktop? Why must we shrink both length and depth by the same factor?" Unequal scale factors distort shapes.

# From footprints to algebra

Let **g** be the width in real centimeters of each of the three equal gaps. The objects use 60 + 20 = 80 cm. Together the objects and gaps fill the 120 cm width.

## Worked example — explain each line

**60 + 20 + 3g = 120**
80 + 3g = 120  (combine the known widths)
3g = 40  (subtract 80 from both sides)
g = 40/3 = 13⅓ cm  (divide both sides by 3)

**Check by substitution:** 60 + 20 + 3 × (40/3) = 120. On paper, g ÷ 10 = 4/3 = 1⅓ cm. Do not round to 13 cm before checking the exact equation.

> Ask: “Point to the 3 in our model. What does g measure? Why does subtracting 80 from both sides preserve equality?” Let the learner point, talk or draw before writing.

## A second strategy — when the first is comfortable

Use spare width: 120 − 60 − 20 = 40 cm. Share it among three gaps: 40 ÷ 3 = 13⅓ cm. Compare this with the equation: both remove the known widths and divide the remainder by three. Which representation helps you explain why?

## Clearly incorrect example — discuss only after the correct one

**Incorrect:** “g = (120 − 80) ÷ 2 = 20 cm.” This counts only two gaps. Substituting into the actual layout gives 80 + 3 × 20 = 140 cm, which exceeds 120 cm. Trace all three gaps, then repair the divisor to 3.

## Area does not use the same scale factor as length

Real desktop area: 120 × 60 = 7,200 cm². Paper area: 12 × 6 = 72 cm². Each length is divided by 10, so area is divided by 100. Mat and tray areas total 2,400 + 600 = 3,000 cm²; uncovered area is 7,200 − 3,000 = 4,200 cm². Sufficient total area alone does not prove that shapes fit.

# My planning sheet

Parent may read or record. Use paper pieces, the worked example and a calculator if helpful; note what support was used. No name, account, upload or score is required.

**1. Scale:** 30 real cm becomes ____ paper cm at 1:10. A 6 cm paper side represents ____ real cm. Explain the operation.

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**2. Width:** label the three gaps on a sketch. Explain what each part of 80 + 3g = 120 represents.

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**3. Change one constraint:** keep the desktop and mat, but replace the tray with a 30 cm-wide by 30 cm-deep tray. Write an equation for three equal gaps, solve it and check. Do three gaps of at least 10 cm still fit?

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**4. Area:** someone divides 7,200 cm² by 10 and reports a paper area of 720 cm². Explain the error and give the correct paper area.

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**Optional later example:** a 100 cm-wide desktop holds the original 60 cm mat and 20 cm tray. Can all three gaps be at least 10 cm? Explain; do not assume that a positive gap meets the minimum.

These are imagined planning constraints, not safety/ergonomic clearances. Few examples cannot establish mastery or retention. Keep sketches and notes privately, or use the observation sheet.

# Parent answers and teaching evidence

**Answers:** 1. 30 ÷ 10 = 3 cm; 6 × 10 = 60 cm. 2. 80 is the combined object width; 3g is three equal gap widths; 120 is total width, all in real cm. 3. 60 + 30 + 3g = 120; 3g = 30; g = 10 cm. Check: 60 + 30 + 30 = 120. Yes, three 10 cm gaps fit exactly; tray depth 30 ≤ 60. 4. Scale both dimensions: 7,200 ÷ 100 = 72 cm². Later: 100 − 80 = 20; equal gaps are 20/3 = 6⅔ cm, below 10. Three minimum gaps require 80 + 30 = 110 cm, so they do not fit.

**Access versus instruction:** larger labels, one direction at a time, oral answers, a parent scribe or calculator change access. Model the relation between a footprint, its width and a term in the equation to teach the concept. Keep both available; calculator use does not show unaided arithmetic. If thirds distract, begin with the changed tray's whole-number answer.

Dyscalculia, math anxiety, attention/working-memory difficulties and reading/language difficulties are distinct, sometimes overlapping concerns. This activity cannot identify or treat them. Discuss persistent difficulty with a teacher or qualified professional. Supports here are options, not diagnosis-specific prescriptions.

## Selected-source parent teaching note

Star, J. R., Caronongan, P., Foegen, A., Furgeson, J., Keating, B., Larson, M. R., Lyskawa, J., McCallum, W. G., Porath, J., & Zbiek, R. M. (2015; revised January 2019). *Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students.* Institute of Education Sciences. Official guide · Full revised PDF.

**What it supports:** this school-focused synthesis addresses algebra in grades 6–12, not one age-specific sample. Table 1 (p. 3) rates analyzing solved problems and using algebraic structure as **minimal evidence**, and intentionally choosing alternative strategies as **moderate evidence**. The worked-example evidence is mixed (p. 5); do not read "recommended" as "proven for every learner." It advises studying correct examples before clearly labeled incorrect ones (p. 9), and comparing strategies after some procedural fluency (p. 3).

**Our application:** discuss each equation line, link terms to the paper layout, then compare spare-width arithmetic with algebra only when comfortable. These original household-model choices are editorial adaptations. This selected-source note is not a systematic review, an original experiment, a clinical intervention, or evidence that our paper project improves learning. The guide does not validate our activity for home use or for dyscalculia. No elementary-only finding is presented as teen evidence.

More parent guidance · Choose another starting point

# Optional extension: when does it fit?

Stay with the original 60 cm-wide mat and 20 cm-wide tray, front-aligned on a 60 cm-deep imagined desktop. Only the desktop width changes. Use the same paper, pencil and ruler; no more cutting is required. These are invented planning constraints, not safety clearances.

## Parent model: name what changes

Let **W** be the desktop width in real centimeters and **g** be each of the three equal horizontal gaps in real centimeters. The object widths still total 80 cm. So **80 + 3g = W**, or **g = (W − 80) ÷ 3**. Ask: “Which quantities stay fixed? Point to what W and g measure.”

Equal gaps for different imagined desktop widths

| Width W (cm) | Spare width W − 80 (cm) | Each gap g (cm) | Every gap at least 10 cm? |
|---|---|---|---|
| 80 | 0 | 0 | No |
| 95 | 15 | 5 | No |
| 110 | 30 | 10 | Yes, exactly |
| 125 | 45 | 15 | Yes |

**Think aloud:** “At least 10” means **g ≥ 10**, including exactly 10. Three gaps need at least 30 cm, so the width must satisfy **W ≥ 110**. Each extra 3 cm of desktop width adds 1 cm to each equal gap. A positive gap can still be too small.




**Model limits:** W = 80 makes the pieces touch; W < 80 would give a negative gap, so this non-overlapping side-by-side layout is impossible. Depth still fits (40 ≤ 60 and 30 ≤ 60). Width alone would not prove fit if we changed depth, orientation or the objects.

# Try a constraint, then explain it

Parent may read, scribe or offer a calculator. Keep the table available. Describe what help was used; this is not a timed test. Discuss one question at a time and stop when useful.

**1.** For W = 104 cm, find each equal gap. Does the layout meet the 10 cm minimum? Show a substitution check.

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**2.** If the minimum gap changes to 12 cm, what is the smallest desktop width? Mark it on your own number line. Is the boundary included?

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**3. Later example:** replace the tray with a 35 cm-wide, 30 cm-deep tray. Keep the 60 cm mat, three equal gaps and a 10 cm minimum. Find the smallest width; then find each gap if W = 140 cm.

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## Parent answers — compare reasoning, not speed

**1.** g = (104 − 80) ÷ 3 = 8 cm. Check: 80 + 3 × 8 = 104. The pieces fit side by side, but 8 < 10, so the minimum-gap condition fails. **2.** W = 80 + 3 × 12 = 116 cm; widths W ≥ 116 meet the condition. A filled boundary point includes 116. **3.** New object width is 60 + 35 = 95 cm. Smallest W = 95 + 30 = 125 cm. At 140 cm, g = (140 − 95) ÷ 3 = 15 cm. Check: 60 + 35 + 3 × 15 = 140. Depth still fits.

**Separate access from teaching:** reading aloud or recording an oral answer changes access. Pointing out the three gaps, modeling the equation or explaining the filled boundary teaches the math. Note both. If symbols distract, start with “80 cm of objects plus three 10 cm gaps”; return to the inequality after the learner explains that relationship. A correct supported answer is not evidence of independent mastery.

## Evidence scope for this extension

This is an original selected-source adaptation of Star et al. (2015; revised January 2019), *Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students*; full citation and links are on page 5. Recommendation 2, pp. 16–23, connects symbolic, numerical, verbal and graphical representations and uses reflective questions. Its rating is **minimal evidence**: six contributing studies varied in populations and methods, and did not test the precise-language component (p. 17). Grades 6–12 guidance is not a single age-14–18 trial. Our table, width-boundary diagram and household prompts are editorial choices, not tested outcomes from those studies. No home-project, dyscalculia-treatment or learning-gain validation is claimed.