

TEACHER AND STUDENT RESOURCE

Correlation and the evidence for a line



NC Math 1 • NC.M1.S-ID.8

Statistics and Probability

Seven instructional sections • 30 multiple-choice tasks • 30 open or performance tasks. Includes exact alignment, teaching models, technology directions where needed, reusable organizers, student workspaces, worked keys and evidence records.

Free sample | Contents

NC.M1.S-ID.8 | NC Math 1 mathematics

This sample contains 32 complete selected pages from the 205-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-24, 53-56, 113-114, 143, 145

Representative activities

M01: sample PDF page(s) 24; original page(s) 23

M02: sample PDF page(s) 25; original page(s) 24

O01: sample PDF page(s) 26-27; original page(s) 53-54

O02: sample PDF page(s) 28-29; original page(s) 55-56

Selected teacher prompts and keys: original page(s) 10, 113-114, 143, 145

Using this sample

Read the preparation and access guidance before using a selected activity.
Keep teacher keys and private preparation pages separate from student copies.
Use the original resource contents to see the scope of the complete packet.

Complete paid download

The complete resource includes the full PDF task bank and teaching materials.

ALIGNMENT

Standard and learning targets

Analyze patterns and describe relationships between two variables in context. Using technology, determine the correlation coefficient of bivariate data and interpret it as a measure of the strength and direction of a linear relationship. Use a scatter plot, correlation coefficient, and a residual plot to determine the appropriateness of using a linear function to model a relationship between two variables.

T1 • Determine Pearson correlation using technology.

T2 • Interpret direction and linear strength in context.

T3 • Combine scatter, correlation and residual evidence to judge a line.

Current NC Math 1 standards apply during 2026–27 and 2027–28. Newly adopted standards begin in 2028–29. Course content is not assigned to a fixed high-school grade.

NAVIGATION

Plan several learning sessions

Warm-up: M01–M04 and O01–O04

I Do: M05–M08 and O05–O08

We Do: M09–M13 and O09–O13

Collaborative practice: M14–M18 and O14–O18

Independent practice: M19–M23 and O19–O23

Small-group reteach: M24–M27 and O24–O27

Exit ticket: M28–M30 and O28–O30

T1: M01, M05, M09, M13, M17, M21, M25, M29, O01, O02, O03, O04, O05, O06, O07, O08, O09, O10, O11, O12, O13, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24, O25, O26, O27, O28, O29, O30

T2: M02, M06, M10, M14, M18, M22, M26, M30, O01, O02, O03, O04, O05, O06, O07, O08, O09, O10, O11, O12, O13, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24, O25, O26, O27, O28, O29, O30

T3: M03, M04, M07, M08, M11, M12, M15, M16, M19, M20, M23, M24, M27, M28, O01, O02, O03, O04, O05, O06, O07, O08, O09, O10, O11, O12, O13, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24, O25, O26, O27, O28, O29, O30

PLANNING

Materials, access and evidence

Materials

Student pages, pencil, straightedge and graph paper. Actual school-approved correlation, regression and graphing technology is required, not optional. Teacher keys are revealed after learners produce evidence.

Prerequisites

Read ordered pairs, distinguish explanatory and response variables, interpret units, evaluate formulas, and use a coordinate plane. Also understand means, signed differences and squared deviations. No exponential fitting is required in this packet.

Pacing

Use two to four selected items per meeting, with more time for technology and study-design tasks. Session 1: interpret representations and model the process. Session 2: construct and analyze jointly. Session 3: collaborate and independently transfer. Session 4: targeted reteaching and exit evidence. The 60-item bank is reusable across multiple sessions.

Access

Read directions, enlarge graphs, allow dictation or alternate input devices, and provide neutral technology navigation support. Keep the data and mathematical demand unchanged. Record answer-supplying cues separately from access support.

Precision

Data are exactly the displayed fictional values. Keep full precision in regression coefficients and intermediate calculations. Final numerical results use 3 decimals unless stated otherwise, with halfway cases rounded away from zero. For open responses, accept values within 0.002 of full-precision calculations. For MC, select the correctly rounded option exactly. Do not use rounded coefficients to judge more precise predictions.

Evidence

Preserve the first independent response. A copied graph or supplied r is not evidence that a learner operated technology. Collect the saved output, screenshot, printout or faithful sketch plus commands/settings and a brief observed demonstration.

LEARNER TOOL DIRECTIONS

Run, record, and check

Use an available, school-approved spreadsheet such as LibreOffice Calc or Google Sheets. The teacher must approve the tool; this packet cannot certify school approval. No new account, installation or personal data is needed for these fictional tables. A calculator with equivalent regression and scatter-plot functions is also acceptable if commands and settings are documented. These instructions were checked against function documentation, not run inside the learner's application.

For every six-pair dataset: put x in A2:A7 and y in B2:B7, one pair per row. Keep row pairing intact. In H2 enter `=SLOPE(B2:B7,A2:A7)`; in H3 enter `=INTERCEPT(B2:B7,A2:A7)`; in H4 enter `=CORREL(A2:A7,B2:B7)`. Some locales use semicolons instead of commas. Keep full precision; display 6 or more decimals in coefficient cells.

In C2 enter `=H$2*A2+H$3` and fill down through C7 for predicted y. In D2 enter `=B2-C2` and fill down for residuals. Create an XY scatter chart using A2:A7 as x and B2:B7 as y. Create a second XY scatter chart using A2:A7 as x and D2:D7 as y; include zero on the vertical scale. Use points, not a category line chart. Label axes, units and residual zero. Save or faithfully sketch the actual outputs and record the app, formulas, ranges and settings.

TEACHER MODEL

From data to a defensible claim

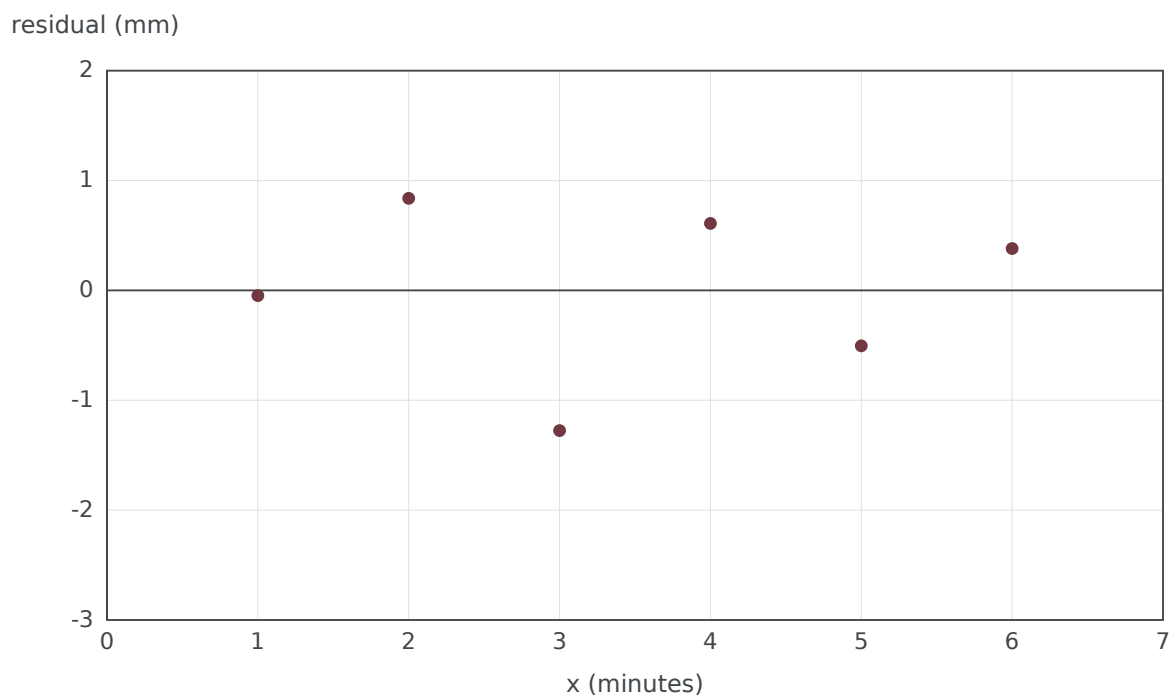
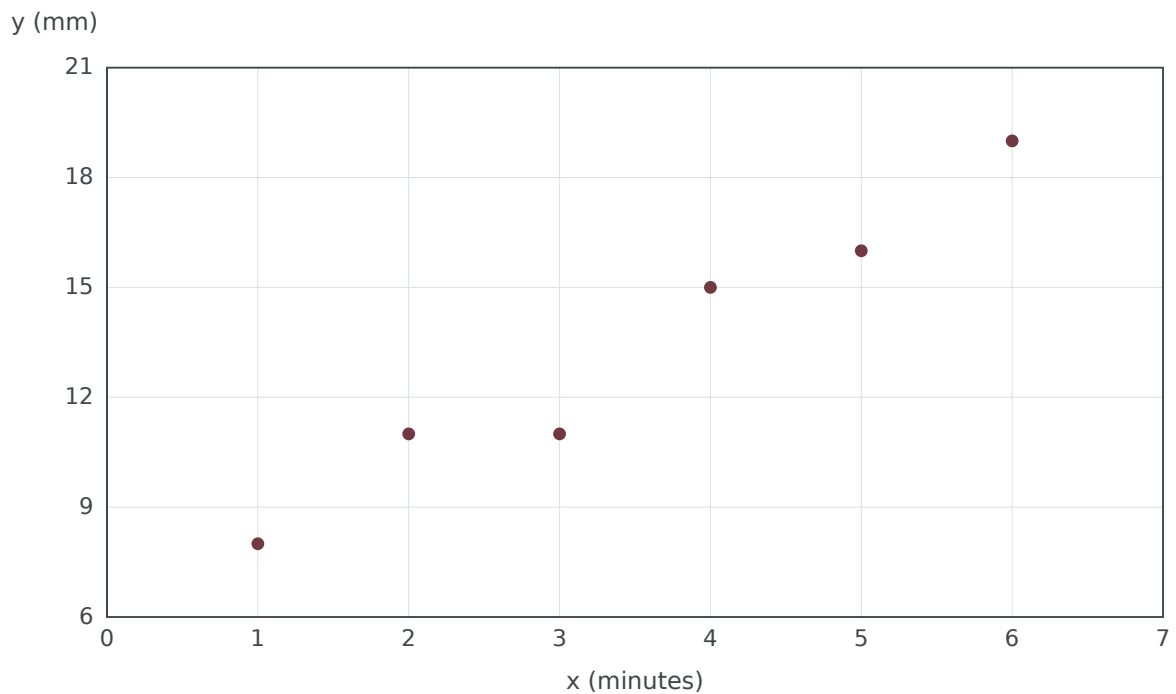
Fictional time x (minutes): 1, 2, 3, 4, 5, 6; travel y (mm): 8, 11, 11, 15, 16, 19. Ask: “What pattern do you predict before fitting? What would a residual tell us?”

$\bar{x} = 3.5$, $\bar{y} = 13.333$; $S_{xx} = 17.5$, $S_{xy} = 37$, $S_{yy} = 81.333$. Slope = $S_{xy}/S_{xx} = 2.114$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} = 5.933$. $\hat{y} = 2.114x + 5.933$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} = 0.981$. Residuals $y - \hat{y}$, in x order: -0.048, 0.838, -1.276, 0.61, -0.505, 0.381. $SSE = 3.105 \text{ mm}^2$. Use full precision internally.

Think aloud: “The residual at $x=3$ is observed 11 minus the model prediction, not the reverse. I inspect the scatter, r and residuals together. A good fit describes these data; it does not establish a causal law.” Require learners to distinguish residual units (mm) from unitless r .

TEACHER MODEL GRAPHS

Scatter and residual evidence



REUSABLE ORGANIZER

Build an evidence chain

Variables, units, domain or study design

Representation / calculations / proposed causal diagram

Evidence supporting and challenging the claim

Conclusion, uncertainty and next evidence needed

WARM-UP

Teaching script and response plan

Core task O01. Optional bank: M01–M04; O01–O04. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Collect a first response. Ask learners to name the two variables and identify what the evidence can establish before calculating or debating the claim.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

WARM-UP

001 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 32.667$; $S_{xx} = 17.5$, $S_{xy} = -53$, $S_{yy} \approx 164.833$. Slope = $S_{xy}/S_{xx} \approx -3.028571$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 43.266667$. Fitted equation: $\hat{y} \approx -3.028571x + 43.266667$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx -0.987$. Residuals $y - \hat{y}$, in x order: -0.238, 0.29, 0.819, -1.652, 0.876, -0.095. $SSE \approx 4.319 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter is approximately straight and $|r|$ is near 1. Residuals occur on both sides of zero, so a line is a candidate descriptive model for this interval. Six points do not rule out a systematic pattern; examine the actual residual sequence and collect more readings before using the model for prediction. Specific residual evidence: at $x=1$, $e=-0.238$; at $x=3$, $e=0.819$; at $x=6$, $e=-0.095 \text{ mm}$. Negative r with $|r|=0.987$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

I DO

Teaching script and response plan

Core task O05. Optional bank: M05–M08; O05–O08. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Model the core task aloud using the exact data. Predict the form first, show each operation or causal arrow, and explain why the conclusion follows. Do not let learners copy a completed graph as independent evidence.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

I DO

005 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 51$; $S_{xx} = 17.5$, $S_{xy} = 62$, $S_{yy} \approx 224$. Slope = $S_{xy}/S_{xx} \approx 3.542857$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 38.6$. Fitted equation: $\hat{y} \approx 3.542857x + 38.6$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.99$. Residuals $y - \hat{y}$, in x order: 0.357, 0.814, -1.729, 0.229, -0.314, 0.643. $SSE \approx 4.343 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter is approximately straight and $|r|$ is near 1. Residuals occur on both sides of zero, so a line is a candidate descriptive model for this interval. Six points do not rule out a systematic pattern; examine the actual residual sequence and collect more readings before using the model for prediction. Specific residual evidence: at $x=1$, $e=0.357$; at $x=3$, $e=-1.729$; at $x=6$, $e=0.643$ mm. Positive r with $|r|=0.99$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

WE DO

Teaching script and response plan

Core task O09. Optional bank: M09–M13; O09–O13. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Ask learners to propose one step at a time. Have a second learner verify units, data pairing and the meaning of a sign or arrow. Invite a competing interpretation and test it against the prompt.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

WE DO

009 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 47.917$; $S_{xx} = 17.5$, $S_{xy} = 54.25$, $S_{yy} \approx 171.208$. Slope = $S_{xy}/S_{xx} \approx 3.1$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 37.066667$. Fitted equation: $\hat{y} \approx 3.1x + 37.066667$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.991$. Residuals $y - \hat{y}$, in x order: 0.333, 0.733, -1.367, -0.467, 0.433, 0.333. $SSE \approx 3.033 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter is approximately straight and $|r|$ is near 1. Residuals occur on both sides of zero, so a line is a candidate descriptive model for this interval. Six points do not rule out a systematic pattern; examine the actual residual sequence and collect more readings before using the model for prediction. The residual runs or end-versus-middle differences warrant checking possible curvature; a reasoned judgment that the line needs further checking is acceptable. Specific residual evidence: at $x=1$, $e=0.333$; at $x=3$, $e=-1.367$; at $x=6$, $e=0.333 \text{ mm}$. Positive r with $|r|=0.991$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

COLLABORATIVE PRACTICE

Teaching script and response plan

Core task O14. Optional bank: M14–M18; O14–O18. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Use reader, representer, checker and explainer roles. Each learner records an initial claim before the group compares evidence. Require each learner to produce a personal conclusion.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

COLLABORATIVE PRACTICE

014 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 48.083$; $S_{xx} = 17.5$, $S_{xy} = 96.75$, $S_{yy} \approx 557.008$. Slope = $S_{xy}/S_{xx} \approx 5.528571$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 28.733333$. Fitted equation: $\hat{y} \approx 5.528571x + 28.733333$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.98$. Residuals $y - \hat{y}$, in x order: 2.438, -0.29, -2.019, -2.248, -0.476, 2.595. $SSE \approx 22.119 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter increases along a curve and residuals are positive near both ends and negative centrally. Even a high positive r does not justify a linear model here; use a curved model or restrict the interval and recheck. Specific residual evidence: at $x=1$, $e=2.438$; at $x=3$, $e=-2.019$; at $x=6$, $e=2.595 \text{ mm}$. Positive r with $|r|=0.98$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

INDEPENDENT PRACTICE

Teaching script and response plan

Core task O19. Optional bank: M19–M23; O19–O23. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Provide the complete task and neutral access supports. Preserve unaided work, technology records and explanations before discussion. Ask only neutral clarification questions.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

INDEPENDENT PRACTICE

O19 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 47.05$; $S_{xx} = 17.5$, $S_{xy} = -45.25$, $S_{yy} \approx 118.275$. Slope = $S_{xy}/S_{xx} \approx -2.585714$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 56.1$. Fitted equation: $\hat{y} \approx -2.585714x + 56.1$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx -0.995$. Residuals $y - \hat{y}$, in x order: -0.714, 0.671, 0.057, 0.443, -0.171, -0.286. $SSE \approx 1.271$ mm². Displayed values are rounded; keep full precision internally. The scatter is approximately straight and $|r|$ is near 1. Residuals occur on both sides of zero, so a line is a candidate descriptive model for this interval. Six points do not rule out a systematic pattern; examine the actual residual sequence and collect more readings before using the model for prediction. The residual runs or end-versus-middle differences warrant checking possible curvature; a reasoned judgment that the line needs further checking is acceptable. Specific residual evidence: at $x=1$, $e=-0.714$; at $x=3$, $e=0.057$; at $x=6$, $e=-0.286$ mm. Negative r with $|r|=0.995$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

SMALL-GROUP RETEACH

Teaching script and response plan

Core task O24. Optional bank: M24–M27; O24–O27. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Use prior evidence to identify the missing connection. Model one contrast, such as observed minus predicted versus its reverse, or association versus random assignment. Then check transfer on a fresh task.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

SMALL-GROUP RETEACH

024 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 45.05$; $S_{xx} = 17.5$, $S_{xy} = -29.75$, $S_{yy} \approx 56.075$. Slope = $S_{xy}/S_{xx} \approx -1.7$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 51$. Fitted equation: $\hat{y} \approx -1.7x + 51$. $r = S_{xy}/\sqrt{S_{xx} \cdot S_{yy}} \approx -0.95$. Residuals $y - \hat{y}$, in x order: -1, 0, 1, 1.5, -1, -0.5. $SSE \approx 5.5 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter is approximately straight and $|r|$ is near 1. Residuals occur on both sides of zero, so a line is a candidate descriptive model for this interval. Six points do not rule out a systematic pattern; examine the actual residual sequence and collect more readings before using the model for prediction. The residual runs or end-versus-middle differences warrant checking possible curvature; a reasoned judgment that the line needs further checking is acceptable. Specific residual evidence: at $x=1$, $e=-1$; at $x=3$, $e=1$; at $x=6$, $e=-0.5 \text{ mm}$. Negative r with $|r|=0.95$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

EXIT TICKET

Teaching script and response plan

Core task O28. Optional bank: M28–M30; O28–O30. Select a few tasks; allow additional sessions for construction and technology.

Learning target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Collect a concise claim with mathematical or design evidence. Do not show a completed answer until responses are preserved; use the evidence to plan the next meeting.

Ask: “Where are the points relative to zero? Does r describe straight-line strength or every possible relationship? What method produced the coefficients?”

EXIT TICKET

028 • Core-task teacher solution

$\bar{x} = 3.5$, $\bar{y} \approx 37.017$; $S_{xx} = 17.5$, $S_{xy} = 0.4$, $S_{yy} \approx 109.262$. Slope = $S_{xy}/S_{xx} \approx 0.022857$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 36.936667$. Fitted equation: $\hat{y} \approx 0.022857x + 36.936667$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.009$. Residuals $y - \hat{y}$, in x order: 5.77, -1.302, -4.485, -4.508, -1.171, 5.696. $SSE \approx 109.253 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter is U-shaped and residuals retain the U-shaped pattern. Correlation near zero describes weak linear association, not absence of a relationship. A linear model misses the curvature. Specific residual evidence: at $x=1$, $e=5.77$; at $x=3$, $e=-4.485$; at $x=6$, $e=5.696$ mm. Positive r with $|r|=0.009$ describes weak linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Evidence response: distinguish a wrong calculation from an unsupported interpretation. Revisit the relevant representation, then choose a fresh item from the bank. Suggested discussion: 10–20 minutes; adjust to evidence and access, never a fluency cutoff.

WARM-UP

M01 • Select and justify

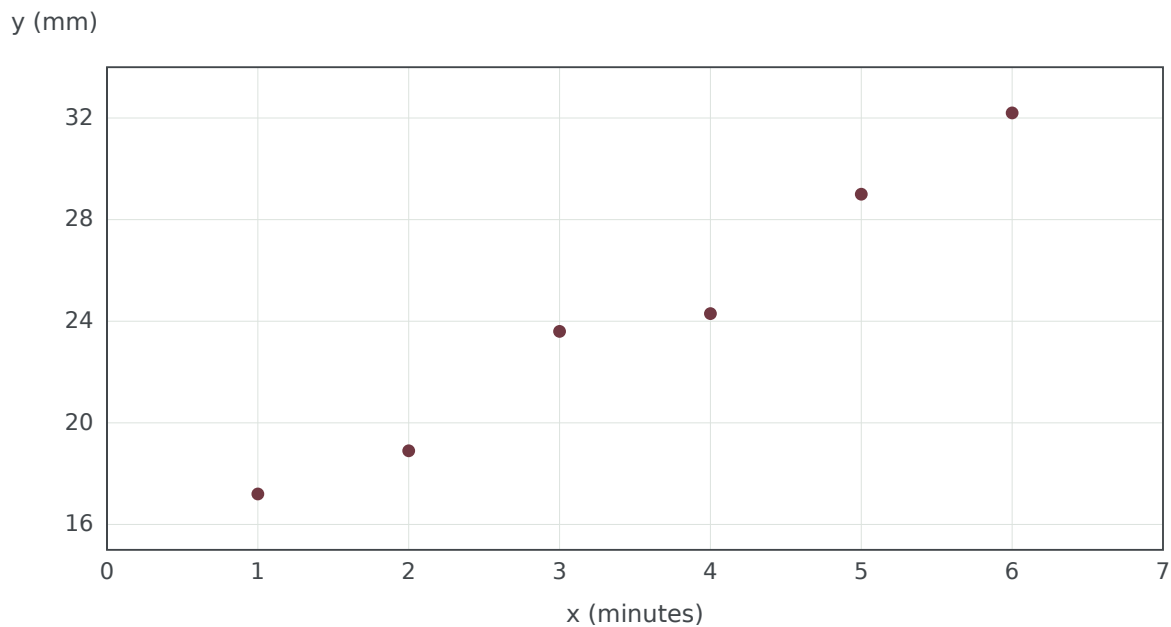
Target: Determine Pearson correlation using technology.

Fictional test rig: x is elapsed time (minutes); y is a position reading (mm).

x: 1, 2, 3, 4, 5, 6

y: 17.2, 18.9, 23.6, 24.3, 29, 32.2

Use technology to compute Pearson correlation r ; round to 3 decimals.



- A. -0.5
- B. 0.988
- C. -1
- D. -0.988

Reasoning / evidence

WARM-UP

M02 • Select and justify

Target: Interpret direction and linear strength in context.

Fictional test rig: x is elapsed time (minutes); y is a position reading (mm).

x : 1, 2, 3, 4, 5, 6

y : 57.3, 53.1, 50.4, 47.7, 44.5, 44.3

Technology gives $r \approx -0.981$. What does this describe?

- A. Little linear association; a curved relationship can remain.
- B. A proven causal effect of time on the position reading.
- C. A strong negative linear association.
- D. A strong positive linear association.

Reasoning / evidence

WARM-UP

001 • Construct and explain

Target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Fictional apparatus: x is elapsed time (minutes); y is a position reading (mm).

x: 1, 2, 3, 4, 5, 6

y: 40, 37.5, 35, 29.5, 29, 25

Use school-approved technology to determine Pearson r and a least-squares line. Record your formulas/commands and full-precision output. Construct a scatter plot and a residual plot, with scales and units. Interpret the direction and linear strength of r. Judge linear-model suitability using all three: scatter, r and residuals. Cite at least two specific observations and explain whether your conclusion establishes causation.

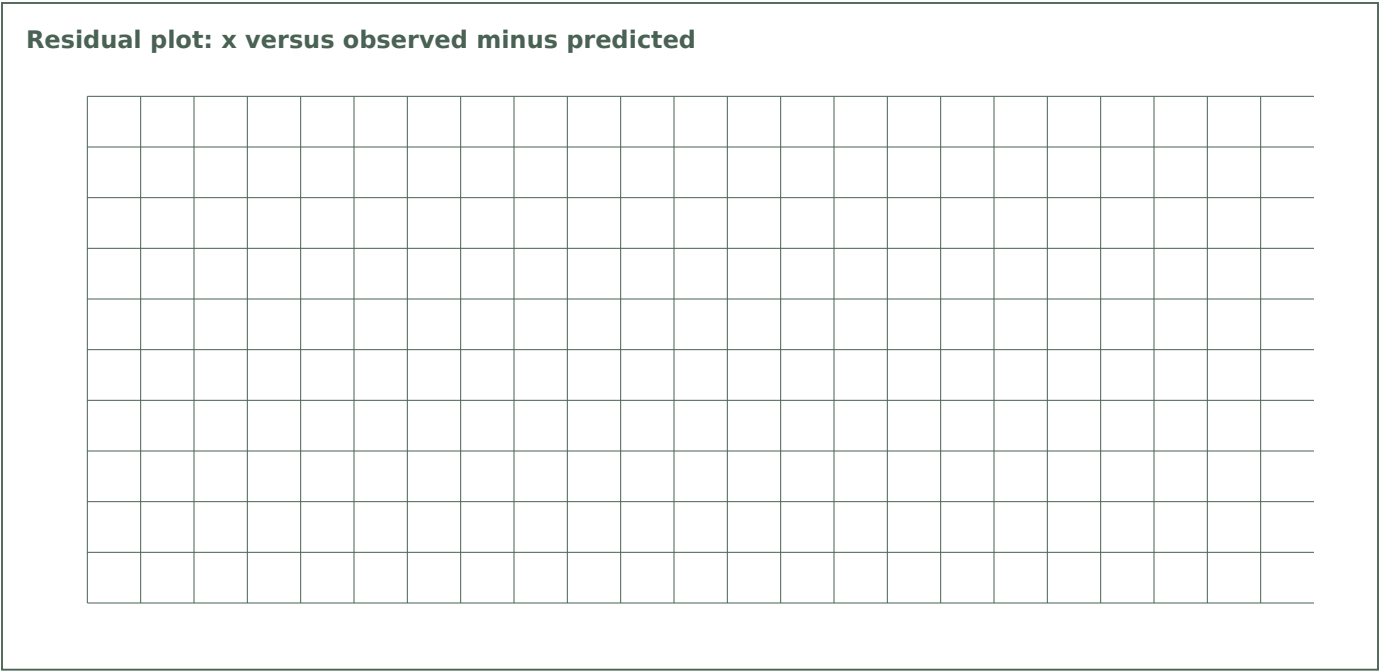
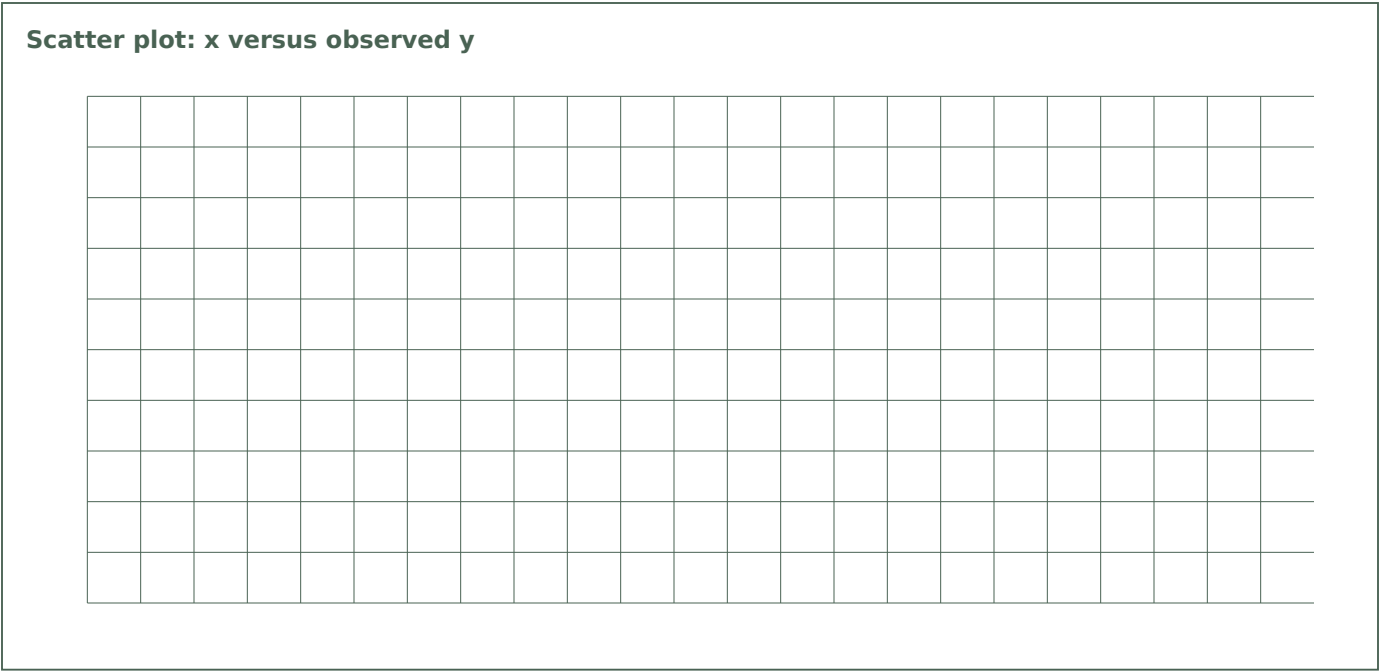
Tool / commands / ranges / settings / full-precision output

Calculations, prediction and evidence-based conclusion

STUDENT CONSTRUCTION

001 • Separate graph workspaces

Use your data and actual tool output from the preceding page. Label axes and units; choose useful scales. Preserve the residual zero line. Attach larger output if needed.



WARM-UP

002 • Construct and explain

Target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

Fictional apparatus: x is elapsed time (minutes); y is a position reading (mm).

x: 1, 2, 3, 4, 5, 6

y: 33.9, 36.4, 40.3, 45.7, 53.2, 62.1

Use school-approved technology to determine Pearson r and a least-squares line.

Record your formulas/commands and full-precision output. Construct a scatter plot and a residual plot, with scales and units. Interpret the direction and linear strength of r . Judge linear-model suitability using all three: scatter, r and residuals. Cite at least two specific observations and explain whether your conclusion establishes causation.

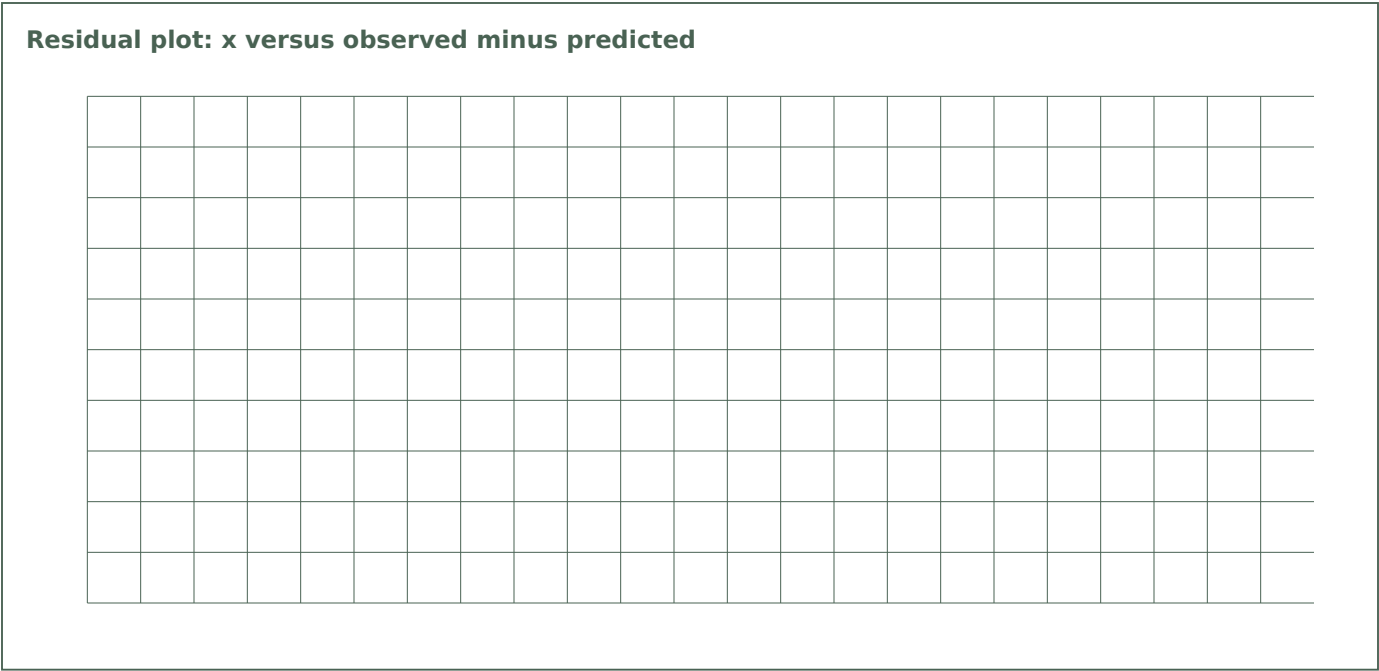
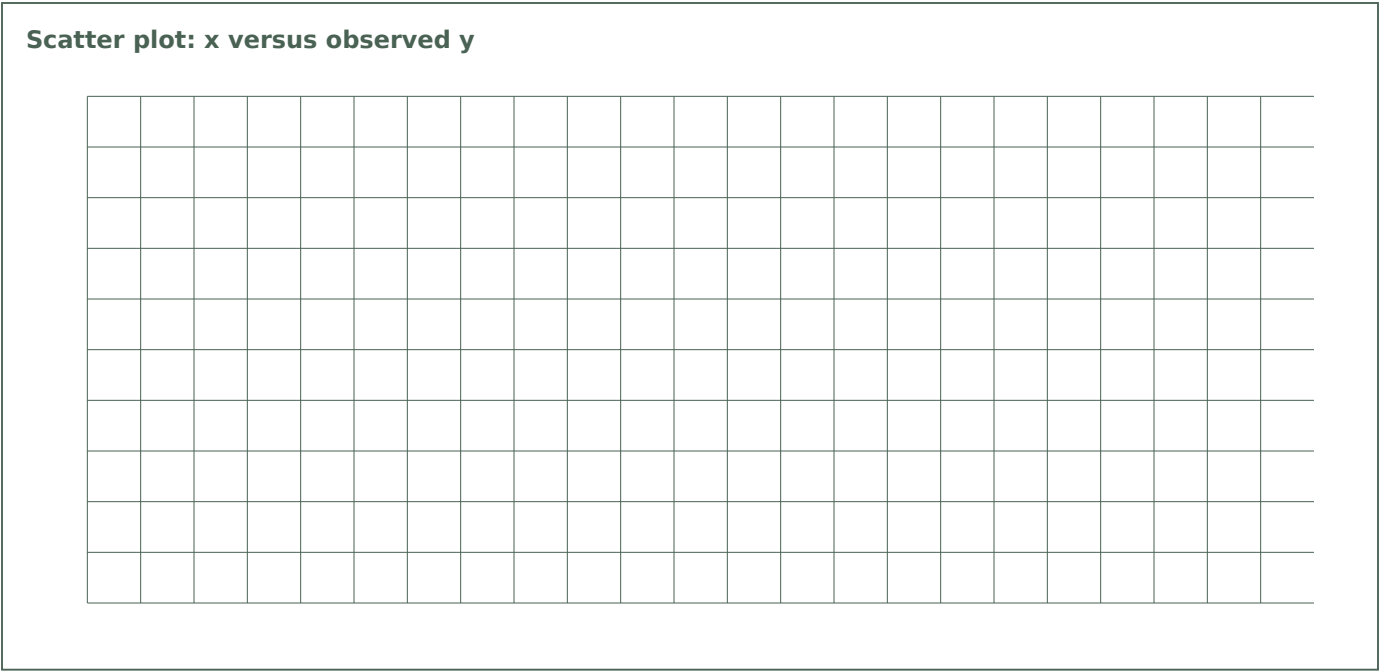
Tool / commands / ranges / settings / full-precision output

Calculations, prediction and evidence-based conclusion

STUDENT CONSTRUCTION

002 • Separate graph workspaces

Use your data and actual tool output from the preceding page. Label axes and units; choose useful scales. Preserve the residual zero line. Attach larger output if needed.



WORKED TEACHER KEY

M01 • Reasoning and evidence

Target: Determine Pearson correlation using technology.

Answer: B. 0.988

$\bar{x} = 3.5$, $\bar{y} \approx 24.2$; $S_{xx} = 17.5$, $S_{xy} = 53$, $S_{yy} \approx 164.5$. Slope = $S_{xy}/S_{xx} \approx 3.028571$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 13.6$. Fitted equation: $\hat{y} \approx 3.028571x + 13.6$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.988$. Residuals $y - \hat{y}$, in x order: 0.571, -0.757, 0.914, -1.414, 0.257, 0.429. $SSE \approx 3.986$ mm². Displayed values are rounded; keep full precision internally. r is unitless and measures linear direction and strength.

A. The exact displayed pairs give $r \approx 0.988$, not -0.5. Use paired rows and do not substitute r^2 , the slope, or a rounded sign.

B. Correct: Pearson $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.988$; it is unitless.

C. The exact displayed pairs give $r \approx 0.988$, not -1. Use paired rows and do not substitute r^2 , the slope, or a rounded sign.

D. The exact displayed pairs give $r \approx 0.988$, not -0.988. Use paired rows and do not substitute r^2 , the slope, or a rounded sign.

WORKED TEACHER KEY

M02 • Reasoning and evidence

Target: Interpret direction and linear strength in context.

Answer: C. A strong negative linear association.

$\bar{x} = 3.5$, $\bar{y} \approx 49.55$; $S_{xx} = 17.5$, $S_{xy} = -46.75$, $S_{yy} \approx 129.875$. Slope = $S_{xy}/S_{xx} \approx -2.671429$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 58.9$. Fitted equation: $\hat{y} \approx -2.671429x + 58.9$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx -0.981$. Residuals $y - \hat{y}$, in x order: 1.071, -0.457, -0.486, -0.514, -1.043, 1.429. $SSE \approx 4.986$ mm². Displayed values are rounded; keep full precision internally. The sign gives linear direction; absolute value describes linear strength, not causal evidence. The scatter is approximately straight with small residuals on both sides of zero and no pronounced curve. A linear model is reasonable for these six observations, but the small fictional sample cannot guarantee future accuracy or a causal relationship.

- A. Here $|r| \approx 0.981$, far from zero, so this is not little linear association.
- B. Correlation alone does not establish a causal effect; no causal design is supplied.
- C. Correct: $r \approx -0.981$ has negative sign and magnitude near 1, indicating strong linear association, not proof of a straight-line model or causation.
- D. The sign of r is negative, not the direction stated.

WORKED TEACHER KEY

001 • Reasoning and evidence

Target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

$\bar{x} = 3.5$, $\bar{y} \approx 32.667$; $S_{xx} = 17.5$, $S_{xy} = -53$, $S_{yy} \approx 164.833$. Slope = $S_{xy}/S_{xx} \approx -3.028571$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 43.266667$. Fitted equation: $\hat{y} \approx -3.028571x + 43.266667$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx -0.987$. Residuals $y - \hat{y}$, in x order: -0.238, 0.29, 0.819, -1.652, 0.876, -0.095. $SSE \approx 4.319 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter is approximately straight and $|r|$ is near 1. Residuals occur on both sides of zero, so a line is a candidate descriptive model for this interval. Six points do not rule out a systematic pattern; examine the actual residual sequence and collect more readings before using the model for prediction. Specific residual evidence: at $x=1$, $e=-0.238$; at $x=3$, $e=0.819$; at $x=6$, $e=-0.095 \text{ mm}$. Negative r with $|r|=0.987$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Assess separately: representation, calculations or design logic, reasoning, and contextual interpretation. For technology tasks, require actual tool use with recorded settings; unsupported copied output is insufficient evidence of the technology target. Accept valid alternative diagrams, explanations and equivalently precise computations.

WORKED TEACHER KEY

002 • Reasoning and evidence

Target: Determine Pearson correlation using technology.; Interpret direction and linear strength in context.; Combine scatter, correlation and residual evidence to judge a line.

$\bar{x} = 3.5$, $\bar{y} \approx 45.267$; $S_{xx} = 17.5$, $S_{xy} = 98.4$, $S_{yy} \approx 578.973$. Slope = $S_{xy}/S_{xx} \approx 5.622857$; intercept = $\bar{y} - \text{slope} \cdot \bar{x} \approx 25.586667$. Fitted equation: $\hat{y} \approx 5.622857x + 25.586667$. $r = S_{xy}/\sqrt{(S_{xx} \cdot S_{yy})} \approx 0.978$. Residuals $y - \hat{y}$, in x order: 2.69, -0.432, -2.155, -2.378, -0.501, 2.776. $SSE \approx 25.684 \text{ mm}^2$. Displayed values are rounded; keep full precision internally. The scatter increases along a curve and residuals are positive near both ends and negative centrally. Even a high positive r does not justify a linear model here; use a curved model or restrict the interval and recheck. Specific residual evidence: at $x=1$, $e=2.69$; at $x=3$, $e=-2.155$; at $x=6$, $e=2.776 \text{ mm}$. Positive r with $|r|=0.978$ describes strong linear association here; strength words are descriptive, not universal cutoffs. No study design assigning a treatment is supplied, so these measurements do not establish a causal effect. Verify learner technology output, rather than awarding the technology target from a copied number.

Assess separately: representation, calculations or design logic, reasoning, and contextual interpretation. For technology tasks, require actual tool use with recorded settings; unsupported copied output is insufficient evidence of the technology target. Accept valid alternative diagrams, explanations and equivalently precise computations.