

Preparation Notes

Please review and customize this deck to prepare it for use. Some notes:

- These professional learning (PL) materials (slide deck and accompanying handout) are being offered in editable forms so that you may make adjustments to better support the specific work happening in your school or district.
- For the 2024–25 school year, student work samples are not provided for most sessions. The facilitator will need to collect or create student work samples when implementing these materials during 2024–25.
- These PL materials are designed to easily accommodate remote delivery:
 - A [Jamboard template](#) is provided to facilitate discussion of student work; the facilitator will need to make a copy of this and be ready to share the link with participants as noted in the deck.
 - Text that can be readily pasted (marked with “—”) into a video call chat feature is included when participants need to reference the handout.
 - There are placeholders for handout links to be shared with participants in the notes field of selected slides; the facilitator will need to add a link to the handout where indicated by “[insert link].”

M112 Overview

XQ Badge Project PL Series Baseline Session

Month XX, XXXX

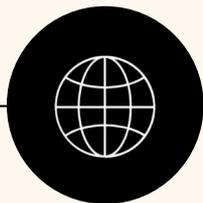


Welcome!

Community Builder:

Write your 6 word math
story. Get ready to share!

Outcomes and Agenda



Participants will be able to:

- Explain the content and practice expectations for the M112 badge
- Analyze tasks through the lenses of (1) content and practice expectations and (2) learning principles
- Analyze student work for evidence of learning

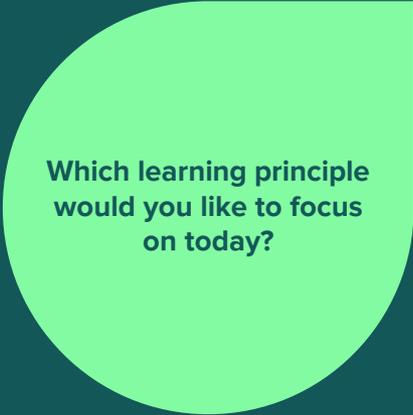


Agenda:

- Task 1: Expectations and Learning Principles
- Task 1: Student Work
- Task 2: Expectations and Learning Principles
- Task 2: Student Work
- Closing

Learning Principles

1. Engage with cognitively demanding tasks in heterogeneous settings.
2. Engage in social activities.
3. Build conceptual understanding through reasoning.
4. Have agency in their learning.
5. View mathematics as a human endeavor across centuries.
6. See mathematics as relevant.
7. Employ technology as a tool for problem-solving and understanding.



**Which learning principle
would you like to focus
on today?**

01

Exploring the Content

What comes to mind?
What knowledge and skills
should students learn to
earn this badge?



Come off mute
or put your
thoughts in the
chat!

What's the Story of these Standards?

Selected Common Core Standards for Mathematics High School – Statistics and Probability

Summarize, represent, and interpret data on two categorical and quantitative variables

5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

Interpret linear models

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.
9. Distinguish between correlation and causation.

**How would you synthesize these?
What are the key takeaways
for students?**

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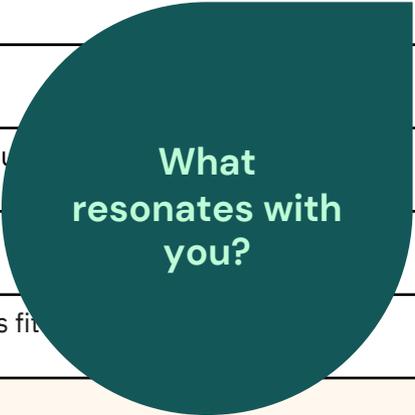
Share your thinking!

M112 Content and Practice Expectations (CPE)

112.a	Engage in the modeling cycle.
112.b	Use scatter plots to represent two-variable measurement data.
112.c	Describe visible patterns between two data sets in a scatter plot.
112.d	Informally fit a straight line for scatter plots that suggest a linear association.
112.e	Fit a linear, quadratic, or exponential function to two-variable measurement data.
112.f	Use functions that have been fitted to two-variable measurement data to answer questions about the relationship being modeled.
112.g	Assess the fit of a function using the correlation coefficient, residuals, and other tools.
112.h	Explain insights gained from analyzing two-variable measurement data and limitations of curves fitted to data.

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**What
resonates with
you?**

M112 Content and Practice Expectations and Indicators

Content and Practice Expectations	Indicators Choose an artifact where you...
112.a: Engage in the modeling cycle.	i. engage with the full modeling cycle (problem, formulate, compute, interpret, validate, revise as necessary, report).
112.b: Use scatter plots to represent two-variable measurement data.	i. construct a scatter plot from collected data
	ii. explain the meaning of a data point plotted on a scatter plot
112.c: Describe visible patterns between two data sets in a scatter plot.	i. identify the type of association visible in a scatter plot
	ii. give a hypothesis that might explain the association identified in a scatter plot



What new
insights do you
have?

Let's Investigate

Choose at least one task to explore:

- Restaurant Bill and Party Size
- Best Phone Charger

Which content and practice expectations are evident in each one?

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Come off mute
or put your
thoughts in the
chat! What did
you find?

What's the Same?

What's Different?

1. How do these content and practice expectations align to ways you've taught this topic before?
2. How are they different?

**Come off mute
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chat!**

Inequity Is our Reality

About

60%

of community college students and 40 percent of four-year students are placed into non-credit bearing developmental mathematics (Ganga et al., 2018)

Only

33%

of community college students complete the developmental math sequence. Only 20 percent complete a college-level math course over three years (Bailey, Jeong, & Cho, 2010).

We Must Lead the Movement

How can this approach give space for what math can be?

Is math...?

- About getting one right answer, the teacher's way
- Irrelevant
- About doing procedures
- Independent work
- Something my teacher made up
- Formulaic

Or could math be...?

- About using multiple strategies flexibly
- Connected to the real-world in ways that make sense
- About understanding and applying
- Collaborative work
- Lived across continents and centuries
- Novel, challenging problems

02

Task 1: Expectations and Learning Principles

Let's Do Some Math!

Part 1: Making Sense of a Scatter Plot

Students are invited to consider graduation rates and the factors that might impact them, using discussion questions such as these:

- *What do you think a state's "graduation rate" is?*
- *What factors might cause a state's graduation rate to be higher or lower?*

After discussing, students are provided this scatterplot and told that each point represents a state; the response variable is the state's graduation rate.

Do the task as a student would. Jot down any reflections that you have as you do the math!

Content and Practice Expectations

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Choose 1-2 Content and Practice Expectations that student work could give evidence of.

Content and Practice Expectations

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112.g: Assess the fit of a function using the correlation coefficient, residuals, and other tools.

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Which of these principles does this task lend itself to? Which ones can the task be easily adapted to accommodate?

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03

Task 1: Student Work

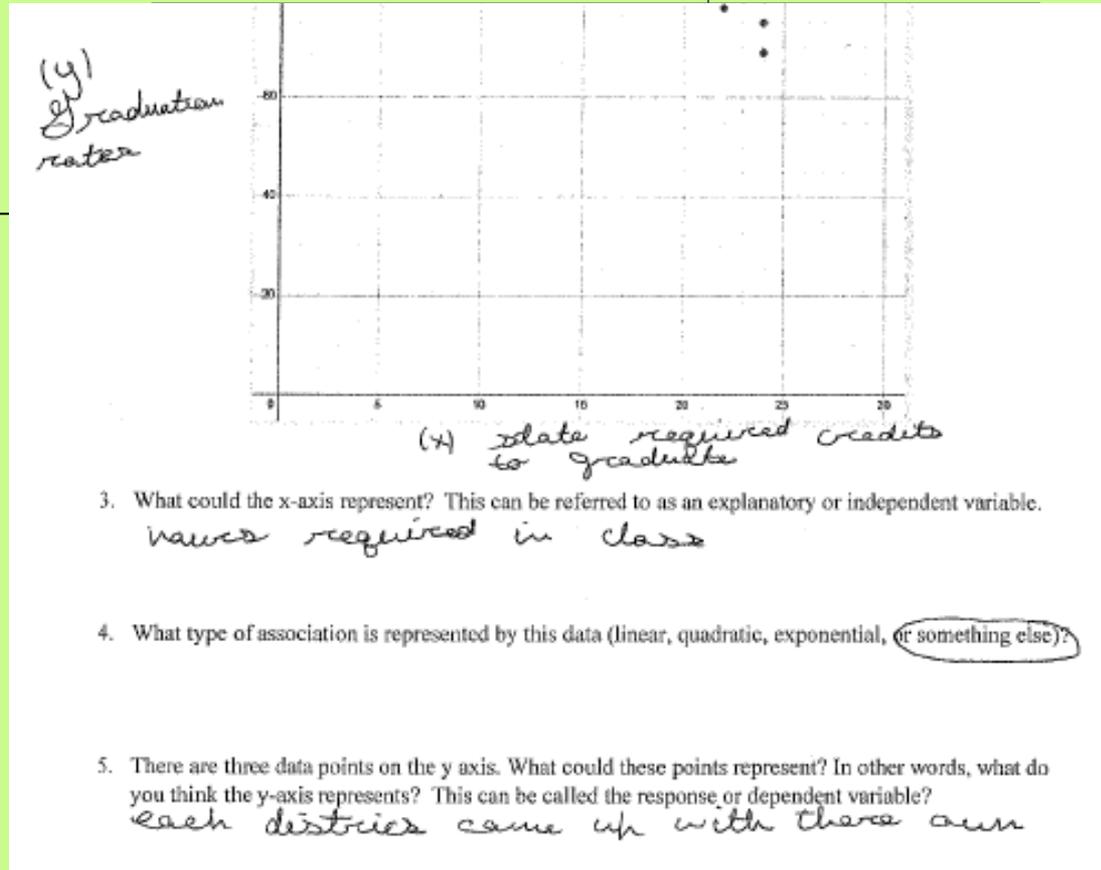
What is the impact of our labels?

“The development of mathematical understanding over the course of human history and for students in classrooms today relies on diverse and multidimensional ways of thinking, learning, and knowing (Boaler & Staples, 2008; Joseph, 2011). Ability labels obscure and distort this fact, compressing mathematical ability into a single linear scale. For example, a student may be fast and accurate with arithmetic computations but struggle to explain their reasoning. Teachers may label such a student “high” or “advanced” because the predominant culture privileges quick computation as an indicator of mathematical ability. But this label omits many important facets of the student’s current strengths and learning needs.” –National Council of Teachers of Mathematics

Round 1: What do you notice?

Jot down

- One thing you notice about each piece of student work.

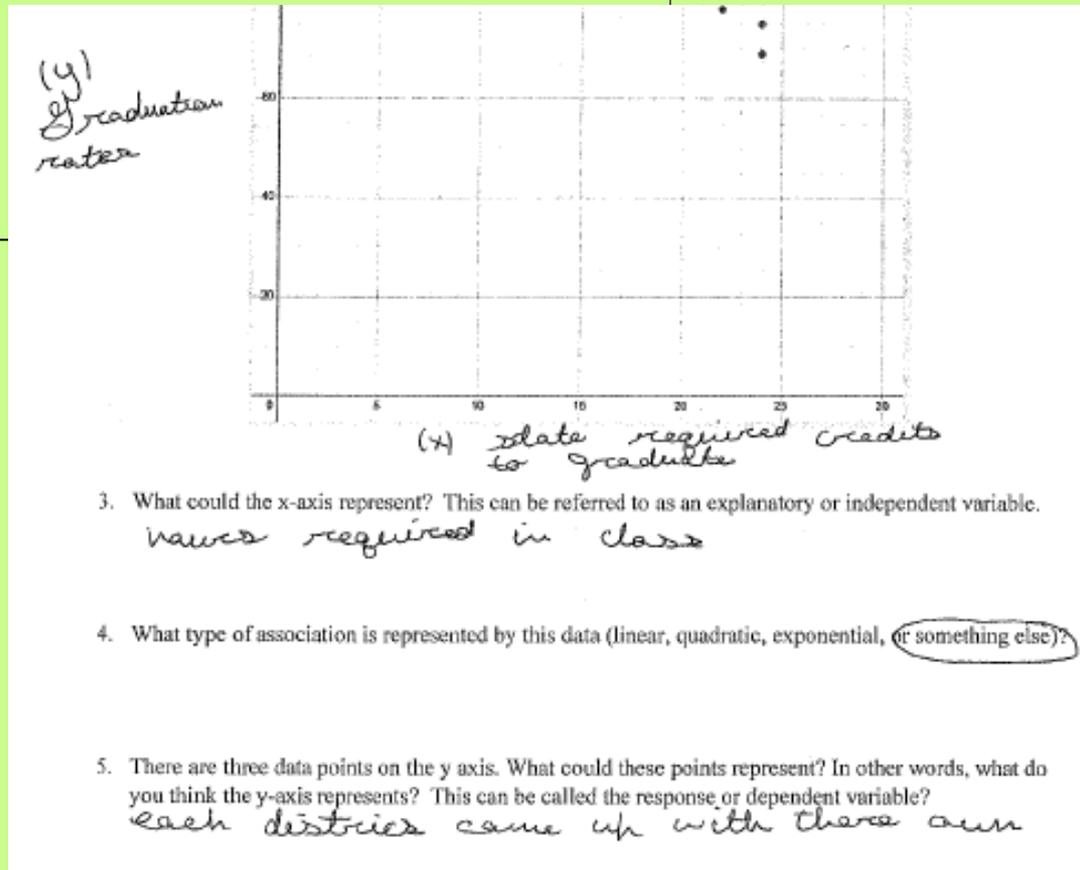


Round 1: What do you notice?

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- One thing you notice about each piece of student work.

Come off mute
and share what
you saw!



Criteria for Success

Conference and Provide Revision Support	Accept with Revision	Accept
<p>The student's artifact shows an emerging understanding of the expectations of the indicator(s). After conferencing and additional instruction/learning, the student may provide a revised or different artifact as evidence of the indicator(s).</p>	<p>The student's artifact is approaching a full understanding of the expectations of the indicator(s). The artifact may contain execution errors that should be corrected in revision. The student may revise the selected artifact or submit a different artifact.</p>	<p>The student's artifact demonstrates evidence that they have met the expectations of the indicator(s).</p>

What resonates with you? What questions surface for you?

Humanizing Assessment

The best learning is driven by students' authentic questions– the kinds of wonderings that keep them up at night and light their cognitive fires. As an educator and instructional leader, you have the power to model relentless curiosity and the power of inquiry (Safir and Dugan, 2021, p. 112).

Source: Safir, Shane, and Jamila Dugan. *Street Data: A Next-Generation Model for Equity, Pedagogy, and School Transformation*. Corwin, 2021.

Round 2: What evidence of learning is there?

112.g: Assess the fit of a function using the correlation coefficient, residuals, and other tools.

Let's examine some work together:

Conference and Provide Revision Support

The student's artifact shows evidence of an emerging understanding of the expectations of the indicator(s). After conferencing and additional instruction/learning, the student may provide a revised or different artifact as evidence of the indicator(s).

Accept with Revision

The student's artifact shows evidence of approaching a full understanding of the expectations of the indicator(s). The artifact may contain execution errors that should be corrected in revision. The student may revise the selected artifact or submit a different artifact.

Accept

The student's artifact demonstrates evidence that they have met the expectations of the indicator(s).

Examining Student Work

The image shows a digital workspace interface for reviewing student work. At the top, there are three buttons: "Conference and Provide Revision Support", "Accept with Revision", and "Accept". On the left side, there is a vertical toolbar with several icons: a pencil, an eraser, a mouse cursor, a document icon (highlighted with a red circle and a red arrow), a photo icon, a circle icon, a text box icon, and a scissors icon. In the center of the workspace, a large red callout bubble contains the text "Put your thoughts on the Jamboard!". In the bottom right corner, there is a red circular badge with the text "Work Sample 1".

Example #1

Interpreting Data

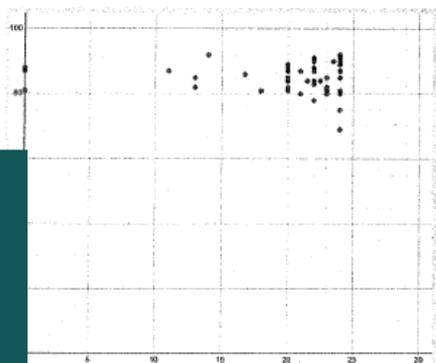
1. What do you think a state's "graduation rate" is?

82%

2. What factors might cause a state's graduation rate to be higher or lower?

students see purpose and meaning

Examine the graph below:



(4)

(4) state required credits to graduate

What does the x-axis represent? This can be referred to as an explanatory or independent variable.

credits required in class

What type of association is represented by this data (linear, quadratic, exponential, or something else)?

5. There are three data points on the y axis. What could these points represent? In other words, what do you think the y-axis represents? This can be called the response or dependent variable?

each districts came up with their own

6. Do you think the number of required courses is a good predictor for high school graduation rate?

yes, more required less people want to do things

7. Now that you know that the response variable is high school graduation rate, what do you think the three data points on the y-axis represent?

students are interested in what they are learning

You will need to do 2 things:

- Label both axes.
- Go to the website in the Nearpod. You will need the information in order to answer the questions.

Once you have completed the two items on the list you can answer the questions below.

8. What are the coordinates for Alabama? What do the coordinates represent?

(20.5, 91)

9. What are the coordinates of Pennsylvania? What do the coordinates represent?

(0, 87)

0 = depends on county

10. How does the meaning of the coordinates of these points compare? Are they tracking the same things?

yes I think so anyway

11. When creating a mathematical model, it is important that the quantities being used are tracking the same things. Why would it make sense to exclude data from Pennsylvania, Colorado, and Massachusetts?

they are all outliers

12. Consider the point (84, 60) on the graph. Determine where this point would be on the graph AND plot the point. What do you notice? What do you wonder?

(84, 60)

Let's compare notes.

Example #2

Part 1: Let's Graduate

Consider graduation rates and the factors that might impact them, using discussion questions such as these:

- What are the basic requirements for graduating from high school?

* passing sustain classes / taking classes

* sustain GPA

* health education

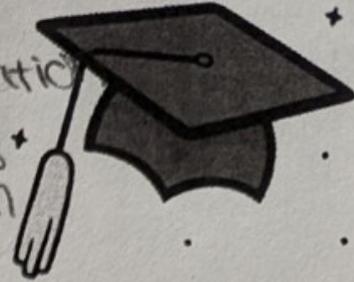
* 1 unit of arts / languages

* consumers education

* SATS

What do you think a state's "graduation rate" is?

How many student graduate



What factors might cause a state's graduation rate to be higher or lower?

* how well schools are

- Teen pregnancy

* people priorities in community

- Education

* how much income families make

- location of school

Let's compare notes.

Example #3

Let's compare notes.

6. Do you think the number of required courses is a good predictor for high school graduation rate?

Yes, because if someone is required to take a lot of required courses, it will take longer to graduate, or someone could go to a different school with less required courses.

7. Now that you know that the response variable is high school graduation rate, what could the three data points on the y-axis represent?

The high school graduation rate with 0 required credits or required classes!

Explore the following resources: [State Course Credit Requirements](#) and the [National Center for Education Statistics' comparison of state graduation rates](#).

8. What are the coordinates for a state like Alabama? What do the coordinates represent?

Most of the coordinates would be closer to 100 on the y-axis and around 24 credits for the x. The coordinates represent the graduation rate and the amount of years.

9. What are the coordinates of Pennsylvania? What do the coordinates represent?

The coordinates are around 80-90 for the y-axis and is different length for the x. The y coordinates represent the graduation rate, and the x coordinates represent the amount of years.

10. How does the meaning of the coordinates of these points compare? Are they tracking the same things?

They are both tracking the same point of graduation rate with a certain amount of required credits!

11. When creating a mathematical model, it is important that the quantities being used are tracking the same things. Why would it make sense to exclude data from Pennsylvania, Colorado, and Massachusetts?

All three are below 90% graduation rates while some like Kentucky and Indiana are above 90%!

Graduation Rates

Part 2: Using a Line of Best Fit

Use technology to estimate and draw in a line of fit for the data set.

1. What does the y-intercept and slope of your line of best fit mean for the given context?

Most students graduate with 10-25 credits required with an average of around 85%.

2. Use technology to fit a regression model to the data. Find the value of the correlation coefficient, r . What does this value mean for the given context?

$$R = -0.075$$

This means if it has a positive or negative correlation.

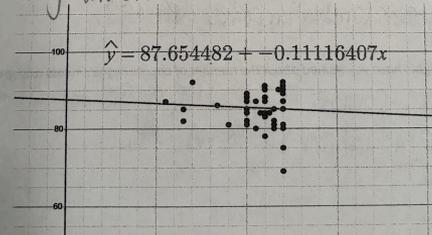
3. Is a linear model a good fit for this set of data?

Yes, these points are almost perfect, in the way that if you draw a linear line of best fit, the plots are almost perfectly even above and below the line.

4. Using technology find the value of the coefficient of determination, r^2 . The coefficient of determination shows the amount of variability accounted for in the model. Does the value of r^2 you calculated validate or dispute the claim that a higher number of required courses in high school lead to higher graduation rates?

$$R^2 = 0.005$$

This disputes the claim because the line is decreasing as the amount of classes are being added.



Three Key Components of the Math Badging System

- Content and Practice Expectations
- Learning Principles
- Criteria for Success

Which one excites you the most?

What one will have the greatest impact on students?

What questions surface for you?



**Come off
mute or share in
the chat!**

04

Task 2: Expectations and Learning Principles

Let's Do Some Math!

Step 1: Developing a Statistical Question

Students are primed with information about heart disease, including what it is and possible contributing factors. Students are asked to brainstorm factors that might decrease a person's risk for heart disease.

Students learn that some believe that individuals with a constant sense of time urgency (often called type-A behavior) are more susceptible to heart disease than are more relaxed individuals. Some psychologists have investigated geographical areas and their relationship to the pace of life. They considered the relationship of city-wide heart disease rates and general measures of the pace of life in the city. Students then collaboratively develop a statistical question to explore involving heart disease and walking speed, such as: Is a higher average walking speed associated with a lower rate of heart disease?

Do the task as a student would. Jot down any reflections that you have as you do the math!

Content and Practice Expectations

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Choose 1–2 Content and Practice Expectations that student work could give evidence of.

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112.h: Explain insights gained from analyzing two-variable measurement data and limitations of curves fitted to data.

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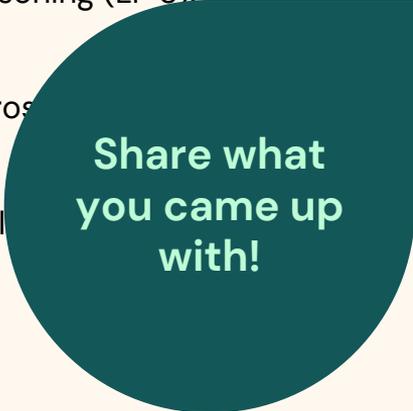
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05

Task 2: Student Work

Round 1: What do you notice?

Jot down

- One thing you notice about each piece of student work.

2. A **relative risk ratio** is a number that compares the possibility of getting heart disease among one group with the possibility of getting that disease in another group. If the risk ratio is 1, that means both groups have the same possibility of getting heart disease. Based on your current understanding, answer the following questions using a factor from your answer to Question 1:

a. What do you believe are the two groups involved?

Older age groups
↓
Genetics

b. What do you anticipate the relative risk ratio will be: about 1, greater than 1, or less than 1? How did you arrive at this conclusion?

old age - ~~1.5~~
Genetic - ~~1.1~~
Researched and found these

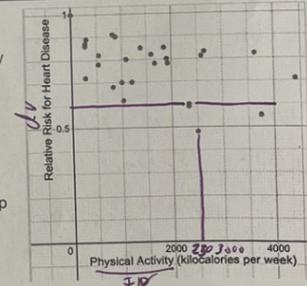
c. What are some statistical questions you can ask about heart disease?

-What groups are most subjective to heart disease?
-What groups have a higher statistic of heart disease?

Part 2: Understand a Mathematical Representation

In one study, researchers set out to quantify the specific amounts of physical activity required for lower risks of heart disease.

- The **explanatory (independent) variable** is the physical activity measured in kilocalories burned per week by participants in various studies.
- The **response (dependent) variable** in the data set below is the relative risk of heart disease, when comparing physical activity during leisure-time with a group who has no leisure-time physical activity.



1. What do you notice? What do you wonder?

This plot is kind of all over the place, it's definitely higher at the beginning but spikes again at the end why?

2. How might you use this graph to answer the statistical question, "Do higher levels of physical activity lower the risk of heart disease?"

Yes, as long as you don't go over board with it, studies show that 2500 - 4000 kilocalories per week in physical activity is ideal, below or above that may put you at risk.

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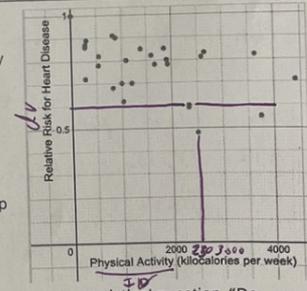
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The student's artifact demonstrates evidence that they have met the expectations of the indicator(s).

Examining Student Work

The image shows a digital workspace interface for reviewing student work. At the top, there are three buttons: "Conference and Provide Revision Support", "Accept with Revision", and "Accept". On the left side, there is a vertical toolbar with several icons: a pencil, an eraser, a mouse cursor, a document icon (highlighted with a red circle and a red arrow), a photo icon, a circle icon, a text box icon, and a scissors icon. In the center of the workspace, a large red callout bubble contains the text "Put your thoughts on the Jamboard!". In the bottom right corner, there is a red circular badge with the text "Work Sample 1".

Example #1

2. A **relative risk ratio** is a number that compares the possibility of getting heart disease among one group to the possibility of getting that disease in another group. If the risk ratio is 1, that means both groups have the same possibility of getting heart disease. Based on your current understanding, answer the following questions using a factor from your answer to Question 1:

a. What do you believe are the two groups involved?

Older age groups

↓
Genetics

b. What do you anticipate the relative risk ratio will be: about 1, greater than 1, or less than 1? How did you arrive at this conclusion?

old age - ~~1.5~~

Genetic - ~~1~~

Researched and found these

c. What are some statistical questions you can ask about heart disease?

-What groups are most subjective to heart disease?

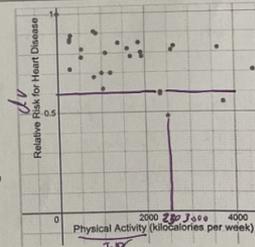
-What groups have a higher statistic of heart disease?

Part 2: Understand a Mathematical Representation

In one study, researchers set out to quantify the specific amounts of physical activity and the associated risks of heart disease.

The **independent variable** is the physical activity measured in kilocalories per week by participants in various studies.

The **dependent variable** in the data set below is the relative risk of heart disease, when comparing physical activity during leisure-time with a group having no leisure-time physical activity.



Notice? What do you

is kind of the place, it's higher at beginning but drops again at the end why?

2. How might you use this graph to answer the statistical question, "Do higher levels of physical activity lower the risk of heart disease?"

Yes, as long as you don't go over board with it, studies show that 2500 - 4000 kilocalories per week in physical activity is ideal, below or above that may put you at risk.

Let's compare notes.

Part 3: Manipulate the Model

Work with this representation of the data on [Desmos Calculator: Physical Activity and Relative Risk for Heart Disease](#) to determine the line of best fit.

Line of best fit: $Y = 0.000526541 + 0.84294$	What is the slope, what does it mean in the context of the problem? MAX 2500 KCPA Slope - 0.000526541 The relationship between risk and the activity, it's not linear.	What is the y-intercept? What does it mean in the context of the problem? Y-intercept (0, 0.843) (4130, 0.025) It's irrelevant, people can't have 0 physical activity, breaking counts.
What is the value of the coefficient of determination, r^2 ? Does the value of r^2 you calculated validate or dispute the claim that a higher level of physical activity lowers the risk of heart disease? $r^2 = 0.1988$ dispute, it is very far from 1.		

Part 4: Interpreting the Model

Do you think that a level of physical activity, quantified by kilocalories per week, is a good predictor of a relative risk for heart disease? Why or why not? Yes and no, a lot of factors were

left out. It seemed like the risk for heart disease only had a few that were below the average line, even with higher kcal, it looked like there was a few with higher dots. So therefore, things like weight and age should be incorporated.

Part 5: Reflection

1. What other variables might contribute to heart disease? Make a list here.

Weight, blood pressure, cholesterol, diabetes, smoking, second-hand smoke, exposure, obesity, diet, physical activity, stress levels, and genetics. Underlying health issues also may play a part.

2. Consider your list of variables. Which ones does your group believe could be a better predictor of a shortened lifespan due to heart disease?

Obesity, the worse ones diet is, and/or physical activity, the higher all those other things may get (blood pressure, cholesterol, risk of smoking, stress, etc)

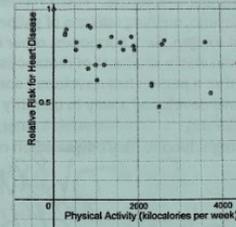
Example #2

Smoking could be a better predictor for heart disease because according to CDC.gov, Smoking increases the number of plaque in your blood vessels. It can also cause blood to thicken and cause clots. These clots then block blood from reaching your heart which can lead to heart disease. The American Heart Association states, "10% of cardiovascular disease is caused by cigarette smoking." That smoking would be a better predictor for heart disease than physical activity levels.

Let's compare notes.

Part 2: Understand a Mathematical Representation

In one study, researchers set out to quantify the specific amounts of physical activity required for lower risks of heart disease. In this scatter plot, the explanatory (independent) variable is the physical activity measured in kilocalories burned per week by participants in various studies. The response (dependent) variable in the data set below is the relative risk of heart disease, when comparing physical activity during leisure-time with a group who has no leisure-time physical activity.



Based on: [Dose response between physical activity and risk of coronary heart disease: a meta-analysis](#)

3. What do you notice? What do you wonder?

I notice that the data is pretty bunched up.
I wonder what the line of best fit would look like?

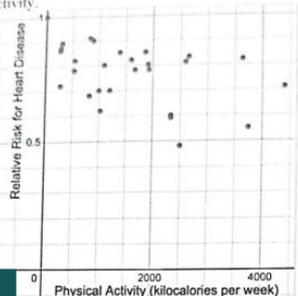
4. How might you use this graph to answer the statistical question, "Do higher levels of physical activity lower the risk of heart disease?"

I would find the r value, the coefficient of correlation, of the graph to see if the 2 variables correlate.

Example #3

Part 2: Understand a Mathematical Representation

In one study, researchers set out to quantify the specific amounts of physical activity required for lower risks of heart disease. In this scatter plot, the explanatory (independent) variable is the physical activity measured in kilocalories burned per week by participants in various studies. The response (dependent) variable in the data set below is the relative risk of heart disease, when comparing physical activity during leisure-time with a group who has no leisure-time physical activity.



between physical activity and risk of coronary heart disease: a meta-

What is the context of the response (dependent) variable?

Risk of heart disease

What type of association is represented by this data (linear, quadratic, power, etc.)?

quadratic

points in the set. Choose one and explain what it means.

if you burn around 2000 kilocalories your risk of heart disease goes down about 50%.

Part 3: Manipulate the Model

There is a link to a representation of the data in Schoology. You should find the link and open it. Use the graph you find to answer the questions below:

How did you decide your line of best fit?

The line that is approximately the same distance away from all the pts

What do the y-intercept and slope mean in the context of this problem?

y-int means that no exercise makes your risk 100%.

slope - the less exercise higher risk

Using technology, find the value of the coefficient of determination, r^2 . Does the value of r^2 you calculated validate or dispute the claim that a higher average speed of walking causes a decrease in lifespan due to heart disease? Why or why not?

$$r^2 = 0.209$$

it doesn't because it is only 20%

Do you think that average speed of walking is a good predictor of a shortened lifespan due to heart disease? Explain why or why not it is a good predictor.

it is not a good one because there is not a ton of correlation between them

Part 4: Reflecting

What other variables do you think contribute to heart disease related death?

daily habits
eating choices
amount of exercise

Consider your list of variables. Which ones does your group believe could be a better predictor of a shortened lifespan due to heart disease?

heredity
daily habits/choices

Let's compare notes.

Let's Hear Some Reflections

What kinds of support will students need to demonstrate evidence of learning?

Has your thinking changed at all on how to implement this task? If so, how?

**Come off
mute or share in
the chat!**

06

Closing

What Are Your Takeaways?

Choose one question to respond to:

1. Which content and practice expectation are you most excited about? Why?
2. Which learning principle are you most excited about connecting to M112 content? Why?
3. What impact do you think using a portfolio system will have on your students? Why?