What Makes a Social Network Strong?

Student Material



Think about the social media platforms you use every day — TikTok, Instagram, X (formerly Twitter), or even YouTube. Have you ever wondered how these networks work? How do they grow, and what makes some networks stronger or more valuable than others?

Did you know that **social networks** don't just exist online? Your friend group, sports team, and even your math class can also be considered social networks! Anywhere people connect, interact, and share ideas is a kind of social network.

Now, here's where it gets interesting: **Robert Metcalfe**, an engineer, came up with a rule that says the more people you're connected to, the more valuable your network becomes. In fact, he claimed the value of a network equals the square of the number of people (or "friends") in it. But does having more connections always make the network better? To find out, choose a company, brand, or organization that interests you — maybe it's a clothing brand, a sports team, or even your favorite YouTuber — and research how many followers they have on their social media accounts (such as Instagram, TikTok, X, etc.).

Using **Metcalfe's law** and the **Pythagorean theorem**, analyze the strength of their social networks. How does the number of followers on each platform compare? Which platform is the most valuable for them? Based on your findings, offer that organization some advice on how they can improve their social media presence. Get creative with how you present your results! You could make a fun presentation, create a video, or even design an infographic. This is your chance to show how math, social media, and real-world businesses connect in surprising ways!

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What Makes a Social Network Strong? *Rubric*

Student Material

		Novice	*Apprentice*	*Practitioner*	*Expert*
Evaluator's Log	**Pythagorean Theorem:** Proof	construction and explanation of a right triangle on graph paper or with objects, focusing on its angles and sides	includes a logical proof of the theorem with graphical representation and written descriptions	• 2 different logical proofs of the theorem with graphical representation and written descriptions • includes constructed right triangles for at least 3 Pythagorean triples • logical proof of the converse of the theorem with graphical representation and written descriptions	all of *Practitioner* plus: identifies at least 4 examples of the Pythagorean triples and explains their significance
	Pythagorean Theorem: Two and Three Dimensions	• includes at least 2 measurable qualities of social networks • combined measure of at least 2 qualities	• includes at least 3 measurable qualities of social networks • combined measure of at least 3 qualities	• justification of at least 3 measurable social network qualities • shows application of Pythagorean theorem to create combined measure of at least 3 qualities of a social network	all of *Practitioner* plus: weighting of different qualities using coefficients/scaling factors to differentiate importance of factors
Organization or Individual		description of an individual or organization with a social media network	description of individual or organization and at least 2 of its social media sites	• description of individual or organization and at least 2 of its social media sites, with network sizes • list of the individual's or organization's use of multiple sites on the same social media platform, with network size for each • list of at least 2 competitors' sites and relative size	all of *Practitioner* plus: tracking of the growth of the social media sites over a 3-week period

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Evaluation Using Pythagorean Theorem and Metcalfe's Law	use of triangle side lengths to represent the size of social networks, on a coordinate grid	• interpretation of social network size on a coordinate grid with right triangles • application of theorem to determine the distance between 2 points on a coordinate grid • calculations of value for 2 smaller social networks	• interpretation of size of social networks, on a coordinate grid with right triangles • application of the Pythagorean theorem to determine the distance between 2 points on a coordinate grid • calculations of Metcalfe's law value for 2 smaller social networks • comparison of the value of 1 social network with 2 others	all of *Practitioner* plus: evaluation of the effectiveness of Metcalfe's law based on data and own assessment of the value of surveyed networks
Recommendation	• aimed at a local, national, or international group that encourages social networks among its members • recommendations are focused on the size of the social network	• aimed at a local, national or international group that encourages social networks among its members • recommendations are focused on the size of the social network, and at least 1 other quality	• aimed at a local, national or international group that encourages social networks among its members • recommendations are focused on the size of the social network, and at least 2 other qualities • includes mathematical evidence for recommendations	all of *Practitioner* plus: evaluation report is presented to the group to implement suggestions with an offer to discuss further and help in its implementation

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What Makes a Social Network Strong? *Scaffold for Learning*

Teacher Material



Benchmark Video and Discussions

- Math in the World
- Prove It
- How Can We Improve Online Networks?

Instructional Activities: Learning

Instructional Texts/Websites

- IXL (**I/P**)
- Khan Academy (**I/P**)
- PBS Learning Media (**I/P**)
- Education.com (**I/P**)
- Flocabulary.com (**I**)
- What is the Pythagorean theorem & how to use it (**I, P, SG**)

Instructional Videos

- Parts of a right triangle (**I, P, SG**)
- Construct right triangles (**I, P, SG**)
- Apply the Pythagorean theorem to determine length of sides (**I, P, SG**)
- Social Media: Social Networking (**I, P, SG**)
- What is Social Networking with Example (**I, P, SG**)

How-to Sheets

- Plot coordinates
- Write a logical proof
- Construct right triangles
- Use a protractor
- Use Metcalfe's law
- Create an infographic
- Write a professional email
- Identify Pythagorean triples

Interactive Websites

- Pythagorean Theorem Game (**I/P**)
- Name the Triangle (**I/P**)
- Pythagorean Theorem Calculator (**I, P, SG**)
- Social Blade (**I, P, SG**)
- Desmos (**I, P, SG**)

Learning Centers

- Parts of a right triangle (**P/SG**)
- Construct right triangles (**P/SG**)
- Identify Pythagorean triples (**P/SG**)
- Pythagorean Theorem and Beyond (Sample Learning Center) (**P/SG**)

Small-Group Mini-Lessons

- Plot coordinates
- Understand squares and square roots
- Exploring how network value grows with connections
- Using the Pythagorean theorem to compare social networks
- Parts of a right triangle

Instructional Activities: Additional

Practice

- Create graphic proof for the Pythagorean theorem (**I, P**)
- Creating Graphs to Compare Social Media Impact (**I, P, SG**)
- Comparing Networks Using the Pythagorean Theorem (**I, P, SG, HW**)
- Researching Social Media Networks (**HW**)

Application

- Apply the Pythagorean theorem to determine length of sides (**I, P, SG**)
- Evaluating Real-World Social Networks (**P, SG**)
- Designing the Perfect Social Networks
- Create a Network Analysis (**I, P, SG**)

Assessment

- Social Media Data Analysis Exit Ticket
- Applying Metcalfe's Law and the Pythagorean Theorem
- Graphing Social Networks
- Rubric Self-Assessment

Reflection

- What was challenging about this unit?
- How well do I understand Metcalfe's law and Pythagorean theorem?
- How can I use Pythagorean theorem in the real world?

Key: Individual **(I)**, Pairs **(P)**, Small Groups **(SG)**, Activities suitable for homework **(HW)**, Insights Video **(IV)**

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What Makes a Social Network Strong? *Transfer Task*

Student Material

Schools are like mini–social networks, with students, teachers, staff, and resources all working together to create a connected community. But just how valuable is our school's network? You will analyze the strength of our school's network using Metcalfe's law and the Pythagorean theorem. By examining how different groups within our school connect and interact, you will propose ways to strengthen these connections and make our school community more valuable and interconnected. Assess the connections within your school (students, teachers, clubs, and resources) and use Metcalfe's law and the Pythagorean theorem to determine how strong the current "school network" is. Based on your findings, propose ways to improve communication and interaction within your school community to make it stronger and more connected.

Include the following:

- I described the concept of a "school network," which encompasses students, teachers, staff, clubs, and various resources.
- I applied Metcalfe's Law to estimate the value of the school's network.
- I correctly used the Pythagorean Theorem to measure or model distances or connections.
- I created a map, diagram, or visual representation of the school's current network.
- I identified gaps or weak points in the school's network, such as isolated groups or poor communication links.
- I proposed realistic and thoughtful ideas to enhance communication and foster connections within our school community.
- I explained how my proposed improvements would strengthen the value and function of the network.
- I clearly communicated my findings through a presentation, report, or product.
- I used math accurately to support my analysis and conclusions.

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What Makes a Social Network Strong? *Facilitation Grid (Week 1 Sample)*

Teacher Material

Student	Classifies a right triangle	Identifies the legs and hypotenuse of a right triangle	States the Pythagorean theorem	Constructs a graphic proof of the Pythagorean theorem	Constructs a written proof of the Pythagorean theorem	Given 3 sides a triangle, can prove if it is a right triangle or not	Calculates the length of the hypotenuse given 2 legs	Compares the values of multiple social media networks	Evaluates real-world social networks

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What Makes a Social Network Strong? *Facilitation Questions*

Teacher Material

COMPREHENSION: *Ask questions that ensure students understand content and skills needed to solve the problem.*	• What is the hypotenuse? • How do we calculate the area of a square? • What has to be true about a triangle for the Pythagorean theorem to work? • What is a social network? • What are the parts of a right triangle?
APPLICATION *Ask questions that ensure the ability of students to apply learning to new situations.*	• What is the length of the hypotenuse of a right-angled triangle with sides 3 and 4? • What is the distance between the points (2,1) and (7,13)? • How could understanding right triangles and their properties be helpful in navigation scenarios, such as planning a trip or determining flight paths? • In any situation where you know the lengths of two sides of a right triangle, how can you use the Pythagorean theorem to find the length of the third side?
CONNECTION *Ask questions that ensure the ability of students to apply learning to their lives.*	• What is the overall value of the social network based on your measures? • In what ways can you evaluate whether your social network is positively or negatively affecting your relationships and mental well-being? How can you use this information to make more informed decisions about the networks you engage with? • Think about how your personal social network (friends, family, classmates, etc.) has grown over time. Compare how the size and diversity of your network have influenced your opportunities to learn new things or meet new people.
SYNTHESIS *Ask questions that encourage students to create new information from existing data.*	• How does Metcalfe's law predict how valuable the social networks are to their users? • What important qualities of a social network determine how valuable users find their social networks? • How can organizations set themselves up to make sure that members and consumers are best served by the interactions they have with one another? • How does the distance between two points relate to rate of change?
METACOGNITION *Ask questions that prompt students to think about their own thinking process.*	• Did you prefer learning about the Pythagorean theorem using shapes and manipulatives, or using graphing? • What effect has this had on how you manage your own "social networks"? • What have you learned about math from applying it in this way?

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What Makes a Social Network Strong? *Teacher Notes Guide*

Teacher Material

Unit Overview

"What Makes a Social Network Strong?" introduces students to real-world applications of both Metcalfe's law and the Pythagorean theorem by analyzing social networks. Students will explore how social networks, both online (such as TikTok, Instagram, and YouTube) and offline (such as friend groups and teams), function and grow in value. Using Metcalfe's law, which states that a network's value increases with its size, students will collect data on follower counts from brands or influencers they are familiar with and compare the value of these networks across different platforms. The Pythagorean theorem will help them further analyze aspects of user engagement, just as it's used in business and science for measuring relationships between different variables. By the end of the unit, students will apply these concepts to make informed, data-driven recommendations on improving social media presence, seeing firsthand how math can be used to understand and influence the digital world they live in.

Common Core State Standards Addressed

8th-Grade Math:

8.G.B.6 Explain a proof of the Pythagorean theorem and its converse.

8.G.B.7 Apply the Pythagorean theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.B.8 Apply the Pythagorean theorem to find the distance between two points in a coordinate system.

Enduring Understandings	Essential Questions
• A right triangle has two legs and a hypotenuse. • For all right triangles, $a^2 + b^2 = c^2$. • The Pythagorean theorem can be used to find the missing side lengths in a coordinate plane and real-world situations.	• Why does the Pythagorean theorem apply only to right triangles? • What is the relationship in the lengths of the sides of a right triangle? • Why does the Pythagorean theorem work?

21st Century Skills Addressed

Core Content and Interdisciplinary Themes

- Subject-Area Mastery

Learning and Innovation

- Critical Thinking and Problem Solving
- Communication and Collaboration

Information and Media Literacy

- Information Literacy
- Media Literacy
- Information and Communication Technology

Life and Career:

- Initiative and Self-Direction
- Productivity and Accountability

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