

Can You Stop in Time? The Algebra of Daylighting

Day 1: Explore Daylighting and Investigate

Teacher: Ms. Wenhui Zeng	
Class: Algebra 1	Grade: 8th Grade Extended Honors
Course Background and Connection to Given Topic: This class is an extended honors algebra math class. The topic includes: linear and quadratic equations and functions; factoring polynomials; radicals; algebraic functions and rational expressions; systems of linear equations and inequalities in two variables; counting and probabilities. This 3-day sequence sits within the Quadratic Functions and Equations unit, directly after instruction on solving quadratic equations (factoring, completing the square, the quadratic formula). Students apply prior algebra skills to a real NYC Department of Transportation policy question - “daylighting,” a street-safety treatment - using real crash data and real intersections they choose themselves.	
Time Frame: 40 minutes	

Lesson Overview

Unit/ Overarching Focus of Lesson:

Using real NYC crash and infrastructure data to build and apply an algebraic decision model for whether a specific intersection needs a pedestrian-safety treatment called “daylighting.”

Objectives/Aims: Students will demonstrate understanding/learning:

- Define and identify different types of daylighting treatments.
- Explore publicly available crash data by geographic area (zip code) on the interactive [webpage](#).
- Rank real intersections by a defined safety criterion.
- Identify the two intersections in a chosen zip code most in need of further investigation, and gather the real-world measurements (posted speed, curb clearance) needed for Day 2’s algebra.

Aligned Standards:

Hunter College High School designs an accelerated curriculum that exceeds New York State mandated guidelines and standards. High school level mathematics study begins in 8th grade. 8th grade extended honors students learn about topics covered in Algebra 1 and 2 from the Next Generation Learning Standards.

- MP4 - Model with mathematics (NYS Standards for Mathematical Practice).

Key Vocabulary and Concepts:

- Daylighting

• Hardened Treatment • Turn Calming • Curb clearance • Posted speed limit	
Materials & Resources: Technology: • Student device with internet access • Interactive webpage Additional Resources: • Field Data Sheet	
Safety Practices: No physical lab hazards. Standard responsible-internet-use guidelines apply when students access the public NYC Open Data website and Google Maps Street View; remind students to use only school-approved devices/accounts per school technology policy.	
Differentiation Strategies: • Provide a pre-filtered, ready-to-rank data table for students who need support with spreadsheet filtering. • Allow pair or small-group work for the data investigation. • Offer NYC maps by borough with zipcodes for students who need a narrower starting point. • Extension for early finishers: research the real safety history of their chosen intersection (news articles, DOT project reports).	
Cultural context: Students select real intersections in their own NYC neighborhoods. Grounding the math in students' own lived environment connects the lesson to real local civic engagement.	
Prior Knowledge: • Solving quadratic equations using quadratic formulas or factoring.	
Prior Lesson: Solving Quadratic Equations (Factoring & Quadratic Formula) - AI-A.REI.4b	Follow-up Lesson: Day 2 - Model: solving for the speed of the car using quadratic formula
Lesson Overview/ Abstract: Students take on the role of a city transportation analyst. Working with real NYC crash data, they select a zip code, rank its intersections by pedestrian/cyclist-injury history, and choose the two most concerning intersections for further investigation. Homework sends them to Google Maps to gather the two real measurements - posted speed and curb clearance - that Day 2's algebra will require.	

Lesson Activities		
Time	Activities	Rationale
10 min	Launch: Define types of daylighting treatments and their roles in traffic safety. Present the real constraint — NYC cannot fund safety upgrades at all 40,000 intersections at once (~\$3B estimated cost). Pose: “If you had funding for daylighting in 2 intersections in your neighborhood, how would you decide?”	Hooks students in an authentic, high-stakes civic decision before any math is introduced; surfaces their intuitive criteria for comparison later.
15 min	Explore: In pairs/small groups, students use Day 1: Investigate interactive webpage to learn more about different types of daylighting. Students choose a zip code to explore crash dataset and rank intersections by count of crashes involving a pedestrian or cyclist injury over the past 3 years and 15 years. Select top 2 intersections.	Builds real data-literacy skills (MP4) and gives every subsequent calculation a genuine, student-chosen real-world anchor rather than a pre-built scenario.
8 min	Discuss: Groups share their zip code and top 2 intersections, briefly justifying their ranking. Class discusses: “What other information would help you decide if these intersections truly need treatment?”	The gap between “documented harm” (crash count) and other risk factors, setting up Day 2’s second criterion (speed/sightline) without stating it outright.
5 min	Homework bridge: Distribute Field Measurement Sheet. For each of their 2 intersections, students look up the posted speed limit (Google Maps) and estimate curb-to-crosswalk clearance via Street View.	Ensures the real inputs (D and posted speed) needed for Day 2’s equation exist before that lesson begins — algebra cannot proceed without them.

Lesson Assessments
Follow-Up Assignment: Completed Field Measurement Sheet (posted speed + estimated curb clearance for both chosen intersections), due at the start of Day 2.
Additional Accommodations for Students: Provide a pre-filtered zip-code data table for students who need reduced data-processing demands.
Methods of Assessment: ● Pair and share ● Class worksheet

Additional Resources:

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- Google Maps/Street View.

Day 2 - Model: Solve and Classify**Lesson Overview****Objectives/Aims: Students will demonstrate understanding/learning:**

- Solve a quadratic equation modeling stopping sight distance to find an intersection's "critical speed".
- Identify and reject a mathematically correct but contextually not applicable solution.
- Compare critical speed to real posted speed and combine that result with real crash data into a two-criterion decision system to classify whether an intersection needs treatment.

Aligned Standards:

- AI-A.REI.4b - Solve quadratic equations by inspection, taking square roots, factoring, completing the square, the quadratic formula, and graphing; recognize when the process yields no real solutions.
- AI-A.CED.3 - Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as "viable" or "non-viable" options in a modeling context.

Key Vocabulary and Concepts:

- Stopping sight distance (SSD)
- Reaction distance
- Braking distance
- Critical speed

Technology:

- Scientific or graphing calculator (or Desmos)

Additional Resources:

- Completed Field Data Sheet from Day 1.
- Complete Day 2 Worksheet online.

Safety Practices: No physical lab hazards. Standard calculator/device use guidelines apply.

Differentiation Strategies:

- Allow use of Desmos to check algebraic work graphically for students who benefit from a visual check.
- Pair students so each partner takes one of the two intersections and cross-checks the other's work.

Prior Knowledge:

- Solving quadratic equations via the quadratic formula.
- Simplifying radicals.

Evaluating a function for a given input.	
Prior Lesson: Day 1 - Investigate: Pick a Zip Code, Find Your Top 2 Intersections	Follow-up Lesson: Day 3 - Decide + Extend: Compare, Graph, Argue, Recommend
Lesson Overview/ Abstract: Using their own two intersections' real measurements from Day 1, students solve a quadratic equation to find each intersection's "critical speed" (the fastest a driver could go and still stop in time), discard the non-viable negative root, and compare that speed to the real posted limit. Combined with their real crash count, this produces a two-criterion classification: does this intersection need daylighting treatment?	

Lesson Activities		
Time	Activities	Rationale
5 min	Launch: Collect Field Recon Sheets. Recap the model $SSD(v) = 0.1v^2 + 3.7v$, a simplified version of a real American Association of State Highway and Transportation Officials (AASHTO) stopping-distance formula, and what v and D represent.	Re-establishes the model's real-world grounding and ensures every student has the two inputs (D , posted speed) needed before solving begins.
10 min	Explore: For each of their 2 intersections, students substitute their measured D into $0.1v^2 + 3.7v = D$, solve using the quadratic formula, and discard the negative root. They compare critical speed to posted speed (Criterion A) and their real crash count to a set threshold (Criterion B), then classify each intersection as needing treatment or not.	Direct application of AI-A.REI.4b and AI-A.CED.3 using the student's own real data.
10 min	Discuss: Compare findings across groups — most intersections fail Criterion A regardless of clearance distance. Class discusses why.	Surfaces the lesson's key conceptual finding: at real urban speeds, sightline distance alone rarely guarantees a full stop, which motivates why cities also weigh cost and crash history, not physics alone.
5 min	Synthesize: Formalize the two-criterion system as an "AND" rule - both criteria must fail for an intersection to be flagged as needing treatment.	Names the mathematical structure (system of constraints) explicitly, connecting the day's

		concrete work back to the standard's abstract language.
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Day 3 - Decide + Extend: Compare, Graph, Argue, Recommend

Lesson Overview
Objectives/Aims: Students will demonstrate understanding/learning: • Calculate a “severity gap” to compare relative risk between two already-classified intersections. • Represent critical speed graphically as the intersection of a parabola and a horizontal line. • Construct a written, evidence-based recommendation using two independent criteria. • (Extension) Solve a quadratic inequality and interpret its solution region in context.
Aligned Standards: • AI-A.REI.7a - Solve a system, with rational solutions, consisting of a linear equation and a quadratic equation (parabolas only) in two variables, both algebraically and graphically. • Extension (Algebra II-level) (optional) - Solving a quadratic inequality and interpreting the solution region — optional/stretch, clearly separated from core Algebra I content.
Key Vocabulary and Concepts: • Severity gap
Materials & Resources: Technology: Desmos (or graphing calculator)
Safety Practices: No physical lab hazards. Standard device-use guidelines apply.
Differentiation Strategies: • Offer both an “argue it” (written) and “score it” (compute crash count $\times$ severity gap) path to the final recommendation, so students can choose the entry point that fits them. • Extension is optional and clearly separated for students ready to go beyond core Algebra I scope. • Provide a memo-writing template with sentence starters for students who need support organizing their argument.
Cultural context: (within which the lesson will be grounded, and specific ideas/practices to be included in the lesson) The final recommendation memo asks students to make a real civic argument about their own neighborhood, mirroring actual public-comment and community-board advocacy processes used in NYC transportation policy (for example, Flushing’s own documented history of resident and elected-official advocacy for Main Street safety improvements).

Prior Knowledge: - Solving a system of equations graphically vs. algebraically. - Graphing a parabola and a linear function on the same axes.	
Prior Lesson: Day 2 - Model: Solve and Classify	Follow-up Lesson: Systems of Linear Inequalities in Two Variables - AI-A.REI.12
Lesson Overview/ Abstract: Students compare their two (already-classified) intersections directly, computing a “severity gap” for each and confronting the real tension of two criteria disagreeing on which is worse. They graph critical speed as the intersection of a parabola and a line, optionally extend into solving the full quadratic inequality, and conclude the unit by writing a real funding-recommendation defending which intersection should be prioritized.	

Lesson Activities		
Time	Activities	Rationale
3 min	Launch: Pose: “Both of your intersections need treatment, but the city can only fund one this year. Now what?” Introduce severity gap = posted speed – critical speed.	Motivates a new metric by naming the genuine real-world constraint (limited funding) the math is being used to resolve.
17 min	Explore: Students calculate severity gap for each intersection and build a side-by-side comparison table (gap vs. crash count). In Desmos, they graph $y = 0.1v^2 + 3.7v$ against $y = D$ for one intersection to see critical speed as the graphs’ intersection point. Early finishers attempt the Quadratic Inequality Challenge (extension).	Directly applies AI-A.REI.7a by reframing already-completed algebra graphically; the comparison table sets up the Discuss step’s real tension.
8 min	Discuss: Class confronts the real tension — one intersection has more documented crashes, the other a bigger severity gap. Which should be funded first, and why?	Surfaces that the model does not resolve the decision on its own - it produces two independent, honest numbers that require human judgment to weigh, which is the authentic civic-reasoning goal of the unit.
12 min	Capstone: Students draft a short funding-recommendation naming which intersection should be prioritized, citing both their severity gap and crash count as evidence.	Summative task requiring students to interpret and communicate quantitative results in a real-world argumentative context - assesses both the

		algebra and AI-A.CED.3's "interpret solutions in context" language.
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Lesson Assessments	
Follow-Up Assignment: Complete writing the funding recommendation.	
Additional Accommodations for Students: Provide the graph pre-drawn with blanks to label for students needing a scaffolded entry to AI-A.REI.7a.	
Methods of Assessment: Summative: Funding Recommendation Memo, graded via rubric (correct algebra/graph - Correct viable-vs-non-viable interpretation - Reasoned argument citing both criteria).	